

FINAL REPORT
January 2018

Final Report

Connecticut State Water Plan

DPH Keeping Connecticut Healthy

OPM

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The Public Utilities Regulatory Authority, the Department of Energy and Environmental Protection, the Office of Policy and Management, and the Department of Public Health constitute the Connecticut Water Planning Council (WPC). This report was prepared by CDM Smith and subconsultant Milone & MacBroom. CDM Smith was contracted by New England Interstate Water Pollution Control Commission (NEIWPCC) as approved by the Connecticut Water Planning Council (WPC).

As required by Connecticut General Statute Section 22a-352, this state water plan has been prepared for the management of the water resources of the state. Also as required by that Statute, the WPC is submitting the state water plan to the joint standing committees of the General Assembly having cognizance of matters related to the environment, public health, planning and development and energy and technology for said committees' approval, revision or disapproval, in whole or in part. Also as required by that Statute, the WPC shall submit such report to the Governor electronically.

For more information, please visit ct.gov/water

Acknowledgements

With sincere appreciation, we thank the Connecticut Water Planning Council for their guidance, endurance and leadership during the development of the State Water Plan. The Public Utilities Regulatory Authority, the Department of Energy and Environmental Protection, the Office of Policy and Management, and the Department of Public Health constitute the WPC.

Thank you to the Water Planning Council members:

- John W. Betkoski, III, Chairman of the Connecticut Water Planning Council and Vice Chairman of the Public Utilities Regulatory Authority (PURA)
- Michael Sullivan, Acting Undersecretary of the Connecticut Office of Policy and Management (OPM)

  Noting acknowledgment also to recent WPC members from OPM: W. David LeVasseur, Vice Chairman of the Connecticut Water Planning Council and Acting Undersecretary of OPM during development of the Plan through July 2017; and to Garrett Eucalitto, Undersecretary of OPM between July and October 2017.
- Lori Mathieu, Member of the Connecticut Water Planning Council and Public Health Section Chief, Connecticut Department of Public Health (DPH)
- Betsey Wingfield, Member of the Connecticut Water Planning Council and Bureau Chief, Connecticut Department of Energy and Environmental Protection (DEEP). Thank you also to DEEP representative Michael Sullivan, who was a Member of the Connecticut Water Planning Council during the first phase of Plan development, through February 2017.



Water Planning Council Members, from right, John (Jack) Betkoski, Lori Mathieu, Michael Sullivan, Betsey Wingfield

So much good work and progress has been made during the 1-year time frame for development of this Final Report. We gratefully thank and acknowledge the participation and thorough review and input from the Water Planning Council, various stakeholders, subcommittee members and public participants. We also appreciate and recognize the historical efforts that many of these same participants, and others that were involved in past progress, which enabled the 1-year development phase to efficiently initiate and progress continuously through preparation of this Final Report.



The WPC Members and Steering Committee at PURA hearing room with public participants.

We thank the Water Planning Council Steering Committee members that comprise the plan's stakeholders. The WPC Steering Committee consists of the four WPC members, plus 15 individuals in leadership roles with subject matter expertise. These members represent a broad range of perspectives, including public water supply companies, environmental protection groups, regulators, industry water users, wastewater treatment providers, and others. Their input during Plan development, along with their active participation during the six workshops held, has greatly contributed to the success of the Plan development. We thank the Steering Committee Members, as shown in Table A-1 below:

Table A-1. Steering Committee Members and Their Affiliation

Steering Committee Member	Affiliation
Elizabeth Barton	Day Pitney
John W. Betkoski III	WPC Member, PURA
Larry Bingaman	South Central Connecticut Regional Water Authority
Chris Clark	Mohegan Tribe
Virginia de Lima	Science & Technical Subcommittee Chair, USGS-scientist emerita
Samuel Gold	Lower CT River Valley Council of Governments
Bart Halloran	Metropolitan District Commission
Elin Swanson Katz	Office of Consumer Counsel
David LeVasseur	WPC Member, OPM
Gene E. Likens	Cary Institute of Ecosystem Studies
Andrew Lord	Lord Law LLC and Connecticut Association of Water Pollution Control Authorities
Lori Mathieu	WPC Member, DPH
Joseph McGee	The Business Council of Fairfield County
Margaret Miner	WPC Advisory Group Co-chair, Rivers Alliance of CT
Robert Moore	Policy Subcommittee Chair
Susan Stratton Sayre	Smith College, Department of Economics
Michael Sullivan	WPC Member, DEEP (Note: Michael Sullivan retired from DEEP in February 2017; and as of November 2017 is a WPC Member, OPM.)
David Sutherland	The Nature Conservancy
Maureen Westbrook	WPC Advisory Group Co-chair, Connecticut Water Company
Betsey Wingfield	WPC Member, DEEP (Note: Replaced Michael Sullivan as DEEP WPC representative following his retirement)
Julie Zimmerman	Yale University, Environmental Engineering

We thank the WPC Advisory Group, whose coordination with work groups to examine specific issues pertinent to preparations for this planning process gave the Plan development a very solid start. The WPC Advisory Group also meets regularly to advise the WPC on procedural aspects of the planning process, as well as on relevant issues and other statewide initiatives. We thank the WPC Advisory Group Members, as shown in Table A-2 below:

Table A-2. WPC Advisory Group Committee Members and Their Affiliation

Name	Affiliation
Margaret Miner (Co-Chair)	River Alliance of Connecticut – Environmental River Protection
Maureen Westbrook (Co-Chair)	Connecticut Water Co. – Large Investor-Owned Water Utility
Curtis Anderson	Anderson Turf Irrigation-Connecticut Irrigation Contractors Association
Eric Brown	CBIA – Business & Industry
Aaron Budris	NVCOG – Regional Council of Government
Karen Burnaska	The Endangered Lands Coalition/CFE – Environmental Land Protection
Josh Cansler	Southeastern Conn. Water Authority – Regional Water Planning
Virginia de Lima	USGS and University of Hartford – Academic: stream flow and ecology
Len DeJong	Pomperaug River Watershed Coalition – Recreation
John Hudak	South Central CT Regional Water Authority-Regional Water Authority
David Knauf	Darien – Public Health Director
Vincent Ringrose	DEP Fisheries Advisory Council-Fisheries
Denise Savageau	Town of Greenwich-Municipal
Richard Sobolewski	Office of Consumer Counsel-Consumer Advocate
Robert Spooner	NRG Energy-Power
Kevin Sullivan	Green Industry
Henry Talmage	Connecticut Farm Bureau-Agriculture
Thomas Tyler	Metropolitan District Commission-Wastewater
Robert Wesneski	Avon Water Co.-Small Investor-Owned Water Utility
Robert Young	Middletown Water & Sewer Dept.-Municipal Water Utility

We thank the WPC Science & Technical Subcommittee, who worked very closely with us during the technical components of the Plan development, including during data accumulation in the early stages of Plan development and during regional basin water summaries development and refinement. We thank the Science & Technical Subcommittee Members, as shown in Table A-3 below:

Table A-3. Science & Technical Subcommittee Participants and Their Affiliation

Name	Affiliation
Virginia de Lima (Chair)	USGS Emerita
Peter Aarrestad	DEEP
Judy Allen	Save Our Water
Melissa Czarnowski	DEEP
Len De Jong	Pomperaug River Watershed Coalition
Mark Decker	Norwich Public Utilities
Eileen Fielding	Farmington River Watershed Association
Corinne Fitting	DEEP
Peter Galant	Tighe & Bond
Sam Gold*	Lower CT River Valley COG
Peter Gorman	CT Association of Golf Course Superintendents
Sally Harold	The Nature Conservancy
John Hudak	South Central CT Regional Water Authority
Lori Mathieu	CT DPH
Margaret Miner	Rivers Alliance
Tony Mitchell	Rivers Alliance
Jonathan Morrison	USGS
John Mullaney	USGS
Brian Murphy	DEEP
David Radka	CT Water Company
Ryan Tetreault	DPH
Glenn Warner	University of Connecticut
Robert Wesneski	Avon Water Company (participated in early part of Plan development)
Bruce Wittchen	CT OPM

We thank the WPC Policy Subcommittee, whose historical efforts enabled us to categorize topics that could be brought to consensus during Plan development along with those topics that require pathways forward to build consensus during Plan implementation. The Policy Subcommittee worked very closely with us during the policy and pathways forward Plan development, including actively participating and presenting policy topics during workshops, and editing draft policy recommendations during Plan development. We thank the Policy Subcommittee Members, as shown in Table A-4 below:

Table A-4. Policy Subcommittee Participants and Their Affiliation

Name	Affiliation
Robert Moore (Chair)	Retired, Past DEEP and MDC positions
Elizabeth Barton	Day Pitney, LLP
Alicea Charamut	CT River Conservancy
Larry Bingaman	South Central CT Regional Water Authority
Melissa Czarnowski	DEEP
Virginia de Lima	USGS, Emeritus
Len De Jong	Pomperaug River Watershed Coalition
Corinne Fitting	DEEP
Betsy Gara	CT Water Works Association
Shelley Green	The Nature Conservancy
Bart Halloran	Metropolitan District Commission
John Hudak	South Central CT Regional Water Authority
Elin Katz	CT Consumer Counsel
Eric Lindquist	OPM
George Logan	Aquarion Water Company
Andrew Lord	Andrew W. Lord, LLC
Lori Mathieu	DPH
Joe McGee	Fairfield Business
Margaret Miner	Rivers Alliance
David Murphy	Milone & MacBroom
Michael O'Neil	University of CT
Matthew Pafford	OPM
David Radka	CT Water Company

Table A-4. Policy Subcommittee Participants and Their Affiliation (continued)

Name	Affiliation
Nick Salemi	Metropolitan District Commission
Martha Smith	West River Watershed Association
David Sutherland	The Nature Conservancy
Maureen Westbrook	CT Water Company
Betsey Wingfield	DEEP
John Viglione	CT Consumer Counsel
Robert Young	Middletown Water Department

In addition to the Water Planning Council and its Steering Committee, Advisory Group, Policy Subcommittee and Science & Technical Subcommittee, we have deep appreciation for those individuals that have participated in various components of the Plan development. Public participation was strong during the six public meetings, during the six workshops, and during the monthly meetings of the WPC and its committees and subcommittees. Many individuals provided comments of support and input so that the Plan was developed incorporating the important components for management of the state's water resources. Following the June 2017 Final Draft Report development, strong support and input continued during the public comment period.

We are awed by the passion and dedication that so many show for this very valuable resource of the state. Working together, this Final Report of the Connecticut State Water Plan can be used as a platform for future water management decisions.



Workshop Participation during Plan Development

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Terms and Acronyms

APA: Aquifer Protection Area

ASR: Aquifer Storage and Recovery

AWWA: American Water Works Association

BF: Baseflow

BFI: Baseflow Index

BMPs: Best Management Practices

CAWPCA: Connecticut Association of Water Pollution Control Authorities

CCM: Connecticut Conference of Municipalities

CCMA: Connecticut Coastal Management Act

CDBG-DR: Community Development Block Grant Disaster Recovery

CEAB: Connecticut Energy Advisory Board

CEDS: Comprehensive Economic Development Strategy

CEPA: Connecticut Environmental Policy Act

CERC: Connecticut Economic Resource Center

CGS: Connecticut General Statutes

CIRCA: Connecticut Institute for Resilience and Climate Adaptation

CIWR: Connecticut Institute of Water Resources

CJL: Coastal Jurisdiction Line

CLEAR: Center for Land Use Education and Research

CMIP5: Coupled Model Intercomparison Project, Phase 5

COGs: Councils of Government

COST: Council of Small Towns

CPCN: Certificate of Public Convenience and Necessity

CRS: Community Rating System

CSO: Combined Sewer Overflow

CTIWR: Connecticut Institute of Water Resources

CTGBC: Connecticut Green Building Council

CTSDC: Connecticut State Data Center

CWA: Clean Water Act

CWF: Clean Water Fund

CWSRF: Clean Water State Revolving Fund

CWWA: Connecticut Water Works Association

CZMA: Coastal Zone Management Act

C&D: Conservation and Development

DBPR: Disinfectants/Disinfection Byproducts Rule

DCS: Department of Construction Services

DECD: Department of Economic and Community Development

DEEP: Department of Energy and Environmental Protection

DEMHS: Division of Emergency Management and Homeland Security

DESPP: Department of Emergency Services and Public Protection

DMR: Discharge Monitoring Report

DOT: Department of Transportation

DPH: Department of Public Health

DPUC: Department of Public Utility Control

DWSRF: Drinking Water State Revolving Fund

DWQMP: Drinking Water Quality Management Plan

EAP: Emergency Action Plan

EASE: Education and Action for Secure Energy

EDR: Estimated Domestic Recharge from Onsite Wastewater Treatment Systems

EDW: Estimated Domestic Withdrawals (from private wells)

EOP: Emergency Operation Plan

ESA: Exclusive Service Area

ET: Evapotranspiration

FEMA: Federal Emergency Management Agency

FMA: Flood Mitigation Assistance

FOIA: Freedom of Information Act

FY: Fiscal Year

GCM: Global Climate Model

GWW: Groundwater Withdrawals

GWUDI: Groundwater Under the Direct Influence

HDe: Hybrid Delta Ensemble

HMA: Hazard Mitigation Assistance

HMGP: Hazard Mitigation Grant Program

HUD: Housing and Urban Development

IDW: Interagency Drought Workgroup

IWQR: Integrated Water Quality Report

IWRD: Inland Water Resources Division

IWWA: Inland Wetlands and Watercourses Act

LGM: Locational Guide Map

LID: Low-Impact Development

MCL: Maximum Contaminant Level

MLRR: Multi-Level Release Rule

MRLC: Multi-Resolution Land Characteristics Consortium

MS4: Municipal Separate Storm Sewer Systems

MWFP: Municipal Wastewater Facilities Plan

M&I: Municipal and Industrial

NCDC: National Climate Data Center

NDRC: Natural Disaster Resilience Competition

NEIWPCC: New England Interstate Water Pollution Control Commission

NEPA: National Environmental Policy Act

NFIP: National Flood Insurance Program

NLCD: National Land Cover Database

NOAA: National Oceanic and Atmospheric Administration

NPDES: National Pollutant Discharge Elimination System

NPS: Nonpoint Sources

NRCS: Natural Resources Conservation Service

NROC: Northeast Regional Ocean Council

OLISP: Office of Long Island Sound Programs

OPM: Office of Policy and Management

P: Precipitation

PCBs: Polychlorinated Biphenyls

PDM: Pre-Disaster Mitigation

PFA: Priority Funding Area

PGA: Professional Golfers' Association of America

PHC: Public Health Code

POCD: Plan of Conservation and Development

POTWs: Publicly-Owned Treatment Works

PURA: Public Utilities Regulatory Authority

PWS: Public Water Supply

PWSMA: Public Water Supply Management Area

QAPP: Quality Assurance Project Plan

RBD: Rebuild by Design

RCSA: Regulations of Connecticut State Agencies

RFP: Request for Proposals

RiverCOG: River Valley Regional Council of Governments

RMCLs: Recommended Maximum Contaminant Levels

RPOs: Regional Planning Organizations

SCCOG: Southeastern Connecticut Council of Governments

SCRCOG: South Central Regional Council of Governments

SCCRWA: South Central Connecticut Regional Water Authority

SDC: State Data Center

SDWA: Safe Drinking Water Act

SF: Stormflow

SFHAs: Special Flood Hazard Areas

SIC: Standard Industrial Classification

SPCS: Significant Potential Contaminant Sources

STEAM: Science, Technology, Engineering, Arts, and Mathematics

STEAP: Small Town Economic Assistance Program

SWAM: Simplified Water Allocation Model

SWAP: Source Water Assessment Program

SWW: Surface Water Withdrawals

SW Disch: Wastewater Discharge to Rivers

THAA: Total Haloacetic Acids

THMs: Trihalomethanes

TMDL: Total Maximum Daily Load

TTHMs: Total Trihalomethanes

UAW: Unaccounted for Water

UCONN: University of Connecticut

UIFs: Unimpaired Flows

USDA: U.S. Department of Agriculture

USFWS: U.S. Fish and Wildlife Service

USGBC: US Green Building Council

USGS: United States Geological Survey

VIC: Variable Infiltration Capacity

VOCs: Volatile Organic Compounds

WICA: Water Infrastructure Conservation Adjustment

WPC: Water Planning Council

WPCA: Water Pollution Control Authority

WPCF: Water Pollution Control Facility

WPCP: Water Pollution Control Plan

WPCSC: Water Planning Council Steering Committee

WPCAG: Water Planning Council Advisory Group

WRDA: Water Resources Development Act

WSA: Water Supply Assessment

WUCC: Water Utility Coordinating Committee

WWIND Rech: Wastewater and Industrial Discharge to Groundwater

WWRI: Whole Watershed Restoration Initiative

AF: Acre feet (measurement of volume equal to an area of one acre with a depth of one foot)

CFS: Cubic Feet per Second (measurement of water flow)

GPCD: Gallons per Capita per day (measurement of water used per person per day)

GPD: Gallons per Day (measurement of water flow)

GPHD: Gallons per Household per Day (measurement of water used per household per day)

KM: Kilometer (unit of length)

MGD: Million Gallons per Day (measurement of water flow)

PPB: Parts per Billion (measurement of contaminant per equal parts water)

In the context of this report, it is important to understand the explicit meaning of the following terms:

Available Water: Water that can be put to consumptive and/or non-consumptive uses within a river basin, whether it originates from streams, reservoirs, or groundwater.

Challenges: Realities in Connecticut's natural, regulatory, or economic environment that may hinder or restrict the way particular options are able to satisfy the goals of the plan. In other words, the challenges are conditions that may inhibit or prevent the implementation of various options.

Consumptive Water Use: Any water use that requires the removal of water from a stream or aquifer, even if some or all of it is returned at a downstream location.

Drainage Basin: The area drained by a river and all its tributaries. Also called catchment area, drainage area, or watershed.

Goals: The overarching statements about what the stakeholders wish the Plan to accomplish.

Incentive/Incentivize: Add advantages that may be monetarily, and/or otherwise, beneficial to users, environment, or recreation. Similar terms may be "promoted"," initiated", and "sponsored", that may help change initiatives and decisions.

Margin of Safety: Unitless ratio of available water to demand.

Non-Consumptive Water Use: Water that is required to remain in place (usually in a stream channel) to serve ecological, recreational, or aesthetic purposes.

Public: Any citizen of Connecticut – all are invited to public meetings and workshops, and will be given opportunity for comments, questions, voicing of concerns, and direct dialogue with state officials and project consultants.

Q50: The streamflow that is equal to the median annual flow that represents instream (ecological flow) needs for summer months.

Q80: The streamflow that is exceeded 80 percent of the time that represents instream (ecological flow) needs for summer months.

Safe Yield: The maximum dependable quantity of water per unit of time that may flow or be pumped continuously from a source of supply during a critical dry period without consideration of available water limitations.

Stakeholders: People representing various water interests, as designated by the Water Planning Council, and who will participate in facilitated discussion during the workshops in order to make consensus recommendations to the WPC. By designation, the stakeholders for this Plan are the members of the WPCSC (Steering Committee), which includes the chairs of the various subcommittees, and by extension, the individuals and organizations represented in those groups.

Water Management Options: Alternative ways that water can be managed in the future, including both supply management and demand management.



Executive Summary

State Water Plan
CONNECTICUT

Preview and Summary

This State Water Plan has been prepared to help planners, regulators, and lawmakers make decisions about managing Connecticut's water in a manner that is consistent throughout the state with stakeholder-defined principles and available scientific data. The Plan in and of itself is not the solution to Connecticut's water issues, but it is a collection of scientific information, policy recommendations, and forward-looking steps that should help frame future water management laws, regulations, and resolution of specific local issues.

This is the first time that Connecticut has had so much scientific information about water consolidated in a single document (one of the goals from the outset). Furthermore, it is the first time that the collective will and objectives of stakeholders representing water interests in all sectors has been formulated as consensus-based policy recommendations. These two facets of the Plan, its consolidated scientific information and its expression of broadly agreeable policy directives, should serve as the platform for ANY future water management decision in the State of Connecticut.

Connecticut has long enjoyed plentiful water resources to meet its needs for drinking water, industry, environmental health, agriculture, energy, and recreation. The State's drinking water sources are among the highest quality in the United States, and new regulations to protect flow for aquatic habitat represent steps toward improving the balance between water that is used outside of its natural environment and water that remains in its natural environment. However, with the pending influence of climate change, new information on ecological flow needs, and economic trends, this good fortune will continue only if the water in the State is managed wisely and consistently in the future. This Plan will help provide such a platform for future water management decisions.

While the Plan contains hundreds of specific recommendations and ideas, it can best be summarized by its five most important points, as determined in collaboration with the Water Planning Council:

1. **PLAN FUNCTION:** The information in the Plan is not an answer, but a consistent platform for decision making based on sound science, guiding principles, and clear roadmaps. If the Plan is used thoughtfully by law-makers, regulators, and planners, and with the interpretive guidance and recommendations from the Water Planning Council, future water management decisions can be consistent, defensible, and broadly aimed at statewide stakeholder objectives.

2. **MAINTAIN HIGHEST QUALITY DRINKING WATER:** Connecticut leads the nation in reserving only the highest quality water (Class A) for drinking water purposes – no other state does so as consistently. The Plan reaffirms the state's dedication to this high standard into the future through both water and land protection.

3. **BALANCE:** As discussed below under "Goals of the Plan," the overarching goal of the State Water Plan is to "Balance the use of water to meet all needs." Many river basins in Connecticut have plentiful water, but many others cannot satisfy current needs (instream needs such as ecological health, recreation, and aesthetics, and out-of-stream needs requiring withdrawals) during droughts or even during typical summer conditions. The Plan enhances awareness of both instream and out-of-stream water needs and the necessary balance between them, and offers many ideas for improving this balance. Further planning is needed, however, to formulate equitable response plans to existing and future pressures such as drought, climate change, development, and water diversions.

4. **CONSERVATION:** While Connecticut leads the nation in protections of drinking water quality, the State lags in its water conservation ethic. Many utilities have already taken steps to promote conservation, and EPA's WaterSense program have resulted in a long-term trend of declining water use in Connecticut, but key to preserving the integrity of high quality drinking water into the future is an increased awareness among consumers of its value and vulnerability. Outreach, therefore, including an understanding of the economic impacts of water conservation and the vulnerability of high quality water to climate, is one of the most important recommendations in this Plan.

5. **MAINTAIN SCIENTIFIC DATA:** The plan advocates for the collection and use of scientific information that will help fill data gaps and aid in future planning, and the preservation of ongoing data collection enterprises, such as USGS streamflow gaging and water use reporting. The Plan also advocates for centralized access to available water-related data via a single portal.

What Does the Plan Mean by "Balance"?

Item #3 above in the list of the five most important points is based on the overarching goal defined by stakeholders, that the Plan should help improve the balance of water use in Connecticut. During the planning process, this was frequently interpreted to mean the balance of uses that rely on the removal of water from its natural environment (withdrawals, diversions, etc.) and those that require water to remain in its natural environment (for aquatic ecology, recreation, and aesthetics). Most of the information in the Plan, then, is based in part on this principle of balance, and is extended to use the familiar planning tool of the "Triple Bottom Line," where alternatives or decisions are evaluated based on their social, environmental, and economic factors. One related aspect to the concept of balance, which was widely brought up during the public comment period following Plan development, is water as a public trust. Following Water Planning Council (WPC) discussion of this prevalent comment, it was noted that there is an existing statute as follows: "Sec. 22a-15. Declaration of policy. It is hereby found and declared that there is a public trust in the air, water and other natural resources of the state of Connecticut and that each person is entitled to the protection, preservation and enhancement of the same. It is further found and declared that it is in the public interest to provide all persons with an adequate remedy to protect the air, water and other natural resources from unreasonable pollution, impairment or destruction."

The paragraphs below help explain exactly how (and where) the Plan strives to improve this balance by promoting human and environmental health, with focused awareness of economic impacts and opportunities.

Human Health



The Plan focuses significant attention on the preservation of high quality water for public health. Specifically, it strongly reaffirms the state's commitment to using only Class A water (the highest quality water occurring naturally) for human consumption (Section 5.2.3.11). The Plan also endorses land protection measured for both surface water bodies and groundwater aquifers so that this high quality of drinking water can be preserved into the future (Section 5.2.3.1). It is important to note that these land protection measures were deemed to be among the Top-Ten policy recommendations in the Plan. Also among the Top-Ten policy recommendations are three sets of measures aimed at increasing the availability of Class A water in the future, or at least reducing the impact of expanded dependence upon it. The first is increased conservation practices throughout the state, following the example already established by many water utilities (Sections 5.2.3.3 and 5.3.2.1). Second, the Plan recommends that Class B water be considered more routinely for non-potable uses in the future, thereby reducing the consumptive use of Class A water for uses that could be lawfully satisfied with other sources (Section 5.2.3.11). Third, the Plan recommends progressive agricultural practices to help reduce impacts of irrigation on other water needs (Section 5.2.3.6). If these recommendations are codified into policy, laws, and/or regulations, the State of Connecticut will have taken important steps toward securing the highest quality of drinking water in the United States for its citizens well into the future. These steps should be accomplished with the understanding that competing needs for water exist in almost every basin in the state, and that the state's new regulations for reservoir releases to support ecological needs downstream of water supply reservoirs can limit the availability of Class A water for future drinking water needs. The steps recommended here to preserve, protect, and enhance Connecticut's Class A water supply sources would be an effective step in balancing human health with environmental health.

Environmental Health



The Plan sheds a great deal of light on new information concerning ecological flow needs in streams throughout the state. In addition to the state's new regulations on Minimum Streamflow Requirements downstream of certain reservoirs, which the Plan endorses in Section 5.2.3.8, the Plan focuses new attention on estimated flow requirements throughout each basin in order to help maintain good ecological health (see Sections 2 and 3, and the Basin Summary Sheets in Appendix E). While the Plan does not recommend that the estimated ecological flow needs be used in a regulatory context beyond the existing Minimum Streamflow Requirements, the Plan does recommend that they be further studied in order to determine potentially allowable variances during periods of drought, and to better understand the impact of maintaining instream flow on water supply yield, margin of safety, cost and the consequences of not maintaining sufficient flow for ecological needs (Section 5.3.2.11). It should also be noted that the estimates of ecological flow needs are necessarily generalized at the regional basin level, and specific needs in local reaches would require further study. The Plan further emphasizes the need to preserve environmental health by encouraging the state to render unused diversion registrations (or certain unused portions of registrations) obsolete, thereby protecting water bodies from future increases in withdrawals beyond what is already expected and planned for (Section 5.2.3.7). Also, the conservation initiatives discussed above, in addition to promoting the future adequacy of Class A water supply for human health, will also help ensure that more flow

can remain in the streams to satisfy environmental needs (Sections 5.2.3.3 and 5.3.2.1). From a water quality point of view, the Plan recommends certain land management practices aimed at preserving or improving water quality throughout the state (Section 5.2.3.2). While many of the environmental aspects of the Plan focus on ecological needs, "environmental health" is more broadly addressed in the Plan as the protection of aquatic habitat *and* the protection of natural resources, both land and water, on which human and non-human life depend. With the endorsements in the Plan noted above, the new information on ecological flow needs throughout the state, and recommendations on how to promote improved instream flow and water quality conditions, the State will have taken important steps toward balancing human and environmental health.

Economic Cost & Benefits



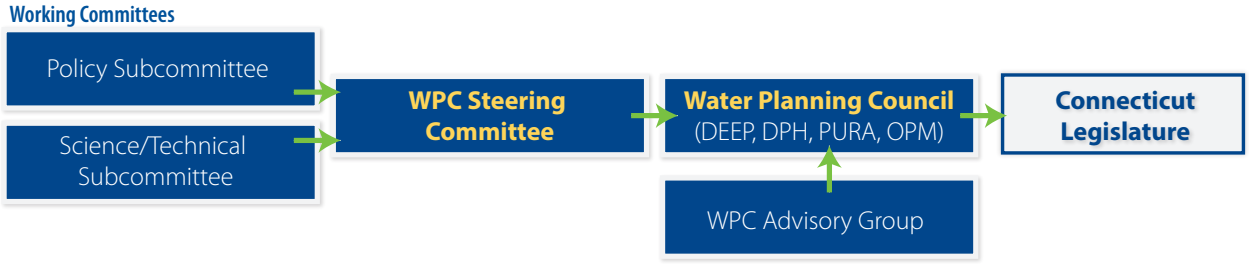
The Plan does not specifically aim to increase economic growth and development, but its recommendations do strive to create awareness of the potential economic impacts associated with water management decisions, and also serve as a platform to indicate where water may be plentiful enough to support future economic growth. In this regard, it may be wise to review the basin summary sheets in Appendix E and individual municipal/utility water supply plans with the Connecticut Economic Resource Center (CERC). It also provides a documented basis for implementing progressive water management strategies where it makes economic sense to do so. Recommendations for better understanding economic impacts of water management are included in Section 5.3.2.5. This section discusses the possibility of an evaluation that compares the implementation of the Plan to NOT implementing the Plan, using either purely financial metrics, or applying Triple Bottom Line methods (social, environmental, and economic), following the example of this section. The Plan also recommends that the WPC determine if there is a consistent way to associate financial value of water for the needs represented in the Plan (including recreational and environmental) and the different types of utility ownership throughout the state. This section also recommends partnerships with Sustainable Connecticut and colleges and universities to address these informational and analytical needs, and concludes by recommending that the WPC formulate a template such that all water-related proposals offered for legislative consideration are accompanied by a consistent financial analysis. In other areas of the report, the Plan recommends that specific economic impacts associated with policy recommendations or next steps be considered. Section 5.3.2.11 recommends that the WPC study the financial impacts of regulatory reservoir releases associated with Minimum Streamflow Requirements. Section 5.3.2.7, which recommends consideration of Class B water for non-potable uses, clearly states that current and potential uses (new or conversions) should be evaluated for cost-effectiveness, and that case studies should be developed to better understand the potential costs (or cost savings) of infrastructure and treatment. Section 5.3.2.2 makes similar recommendations with respect to the possible case-by-case evaluations of regionalizing water systems. Likewise, Section 5.3.2.1 recommends further examination of the economic viability and potential benefits of conservation incentives and changes in billing frequency.

Background

On July 1, 2014, Public Act 14-163, "An Act Concerning the Responsibilities of the Water Planning Council," became effective in the State of Connecticut. The Act directs the state's Water Planning Council to develop a State Water Plan in accordance with 17 specific requirements as shown below.



CDM Smith | Milone & MacBroom



"Not later than July 1, 2017, the Water Planning Council, established pursuant to section 25-33, as amended by this act, shall, within available appropriations, prepare a state water plan for the management of the water resources of the state."

The Water Planning Council (WPC) is comprised of representatives of the four state agencies with oversight or regulatory responsibility for water management:

- Department of Energy and Environmental Protection (DEEP)
- Department of Public Health (DPH)
- Office of Policy and Management (OPM)
- Public Utilities Regulatory Authority (PURA)

The WPC responded to Public Act 14-163 by reviewing methods by which other states had developed statewide water plans, evaluating current practices, future challenges, and opportunities within Connecticut's water management framework, and focusing the work of its Policy Committee, Science and Technical Committee, and Advisory Group on the elements and outline of the Plan. In May of 2016, the Water Planning Council, acting through the New England Interstate Water Pollution Control Commission (NEIWPCC), contracted with CDM Smith and subconsultant Milone and MacBroom to provide professional consultation and facilitation services throughout the development of the Connecticut State Water Plan (the "Plan").

Historically, Connecticut has enjoyed a bountiful supply of fresh water to meet the needs of households and businesses, agriculture, the

Requirements of the State Water Plan

1. Identify the quantities/qualities of water available
2. Identify present/projected demands for water
3. Recommend utilization of water resources to balance public water supply, economic development, recreation and ecological health
4. Recommend steps to increase the climate resiliency of existing water resources and infrastructure
5. Recommend technology and infrastructure upgrades, interconnections and/or major engineering works
6. Recommend land use and other measures to ensure the desired water quality/abundance and promote development in concert with available water resources
7. Take into account desired ecological, recreational, agricultural, industrial and commercial use of water bodies
8. Inform state residents on the importance of water resource stewardship/conservation
9. Establish conservation guidelines/incentives for water conservation with energy efficiency consideration
10. Develop a water reuse policy with incentives for matching the water quality to the use
11. Meet data collection and analysis needs to provide for data driven decisions
12. Account for the ecological, environmental, public health/safety and economic impact implementation will have on the state
13. Include short and long-range objectives/strategies to communicate and implement the plan
14. Incorporate regional and local plans/programs for water use and management
15. Promote intra-regional solutions and sharing of water resources
16. Develop and recommend strategies to address climate resiliency
17. Identify modifications to laws/regulations necessary in order to implement recommendations

environment, energy, and industry. According to a report on a Situation Assessment[1] from 2015:

> **"According to a water allocation model done in the 1980s, less than 20% of water is used for actual consumptive use. Per person usage has declined dramatically in the recent past, possibly due to water-efficient appliances, conservation, and consciousness of water usage. However, some suggested that peak water usage associated with turf or lawn watering is increasing."**

While Connecticut has historically enjoyed plentiful, clean water, unique factors in the state have combined to warrant an evaluation of water management options in the future:

- The recent drought in 2016 raised awareness, even in Connecticut, river basins can become depleted.
- Connecticut is the only state in the U.S. that prohibits wastewater discharges to drinking water sources, preserving our highest quality waters for drinking (Class A). This maximizes health benefits and minimizes treatment costs. This could, however, limit future drinking water sources. High quality waters are critical to stream health and solely relying on these sources to meet consumptive demands could also have environmental impacts.
- New state streamflow requirements downstream of water supply reservoirs are highlighting the ecological need for water, which must be balanced with other water needs.
- Future climate trends in the northeast are uncertain, and planning for adaptation is essential.

It is because of these unique characteristics and uncertainties that a State Water Plan is needed for Connecticut. Ensuring that all needs for water in the future are satisfied involves focusing on new and emerging challenges.



1 Situation Assessment in Support of State Water Planning Workshop, Podziba Policy Mediation, June 25, 2015.

Goals of the Water Plan

The overarching goal of the Plan, as defined by participating stakeholders in the first workshop of the planning process, has been to "Balance the use of water to meet all needs." More specifically, the goals included protection of public health and quality of life, protection of the environment, cost-effective water management, preparation for uncertain future climate conditions, reliance on science and data, and inclusion of Connecticut citizens in water management. **Phrased together, the Plan aims to protect water quantity and quality for all of its current and future uses when regulations, climate, and economic conditions are changing. To do so, it provides technical information and policy recommendations to help inform legislative and regulatory decisions.**

The Plan does **not** attempt to prioritize any particular water use or water use category over others; that is, instream needs and out-of-stream needs are not prioritized but are accounted for in each basin's ability to provide for these needs with naturally available water. Likewise, the value of specific uses of water, if currently authorized by state policies and law, are neither advocated nor diminished relative to other uses. Instead, the Plan provides technical information and guiding principles that may be used to inform decisions across the state on a case-by-case basis, or in the form of future legislation.

Stakeholder-Defined Goals for the State Water Plan

1. Provide reliable and resilient supply for all uses
2. Promote public health and quality of life with high quality water
3. Protect the Environment
4. Manage water cost-effectively for all uses
5. Develop an implementable plan
6. Prepare for uncertain future climate
7. Use science and data to recommend action
8. Involve Connecticut citizens in water management

In compliance with the statute authorizing the Plan's development, the Plan aims to satisfy all 17 requirements as specified. Some of these are accomplished fully in this report itself, while others can only be satisfied with ongoing collaboration, scientific evaluations, etc. At a minimum, the Plan provides information and a framework to move forward to address each of the 17 requirements in the State Statute. See Section 1.4.2 of the report for a comprehensive discussion of these requirements and how the Plan addresses each one.

Future Water Management Options to help Achieve Plan Goals

Policy and Planning Options

- Land use practices and protection
- Water conservation, incentives, rate structure
- Incorporation of existing local and state plans (i.e., water supply, energy, land, conservation)
- Regionalization of water supply and appropriate interconnections
- Identify funding mechanisms for Plan implementation and updates
- Develop monitoring plan for Plan implementation
- Statewide drought planning and mechanisms to enforce water restrictions
- Future Class B water for non-potable uses
- Water use accounting
- Ground water and private well monitoring and protection

Technology Options

- Technology and facility improvements / replacement
- Water reuse and greywater use
- Wastewater management
- Stormwater management
- Desalination
- Flood management
- Leak detection
- Real-time flow monitoring

Regulatory Options

- Address registered diversions
- Implement instream flow regulations
- Changes to laws / regulations

Outreach Options

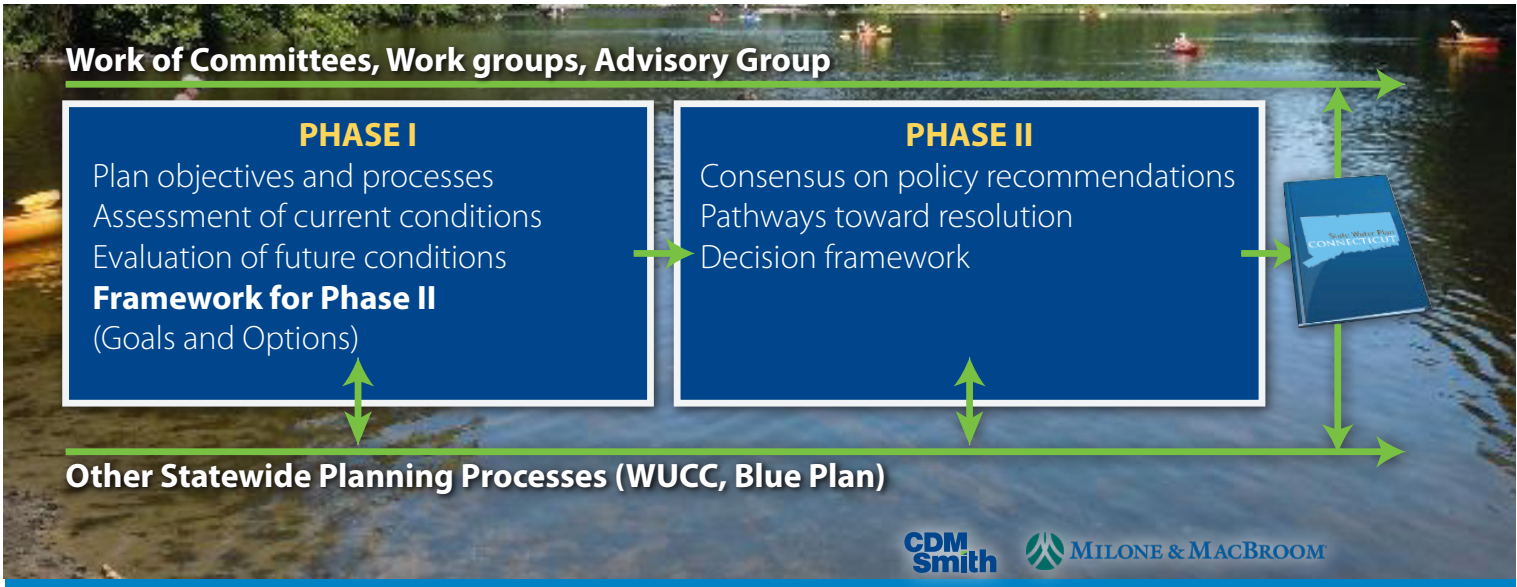
- Public education (short and long term goals)

What the Plan Contains and Does Not Contain

This report is the final report of the Plan development process, and will be turned over to the WPC to finalize it by December 31, 2017. As such, it contains the following:

- Overview of the Goals and Planning Process (Sections 1 and 4)
- Current Condition Assessment (Technical and Policy – See Section 2)
  - Current water use patterns and natural water availability
  - Current water quality
  - Current water policies and management structure
  - Assessment of land conservation and economic conditions
- Future Condition Evaluation (Technical and Policy – See Section 3)
  - Future water needs compared with natural water availability
  - Potential impacts of climate change on future water availability
  - Potential effectiveness of water conservation strategies
  - Future options for progressive water management
  - Challenges to meeting future water needs and/or applying the progressive options
- Recommended Policies for legislative and regulatory guidance, developed by stakeholder consensus (Section 5)
- Recommended roles for the WPC, its committees, and conflict resolution strategies (Section 5)
- Pathways toward resolution for issues that require more information, more outreach, or consensus-building before consensus-based recommendations can be made (Section 5)
- Implementation Guidelines, including funding strategies, local participation, use of technical information, adaptive water management, tracking against the Plan's goals, etc. (Section 6)

Understanding what the Plan does is equally important to understanding what this Plan does NOT attempt to do. The Plan is not the solution to all of Connecticut's water issues, nor is it an attempt to resolve them all. Rather, it is a framework for future decision making; technical information combined with policy recommendations and recommended next steps for data expansion and outreach should serve collectively to inform legislative and regulatory decisions, as well as project-specific decisions. The Plan does not rule out any specific water use, nor does it elevate or diminish the value of any particular use relative to other uses. Instead, it will help decision-makers determine the viability of future water needs and uses scientifically, and with consistent guiding principles.



How to Use This Plan

This is the first time that Connecticut has had so much scientific information about water consolidated in a single document. Furthermore, it is the first time that the collective will and objectives of stakeholders representing water interests in all sectors has been formulated as consensus-based policy recommendations. These two facets of the Plan, its consolidated scientific information and its expression of broadly agreeable policy directives, should serve as a guide for future water management decision-making in the State of Connecticut.

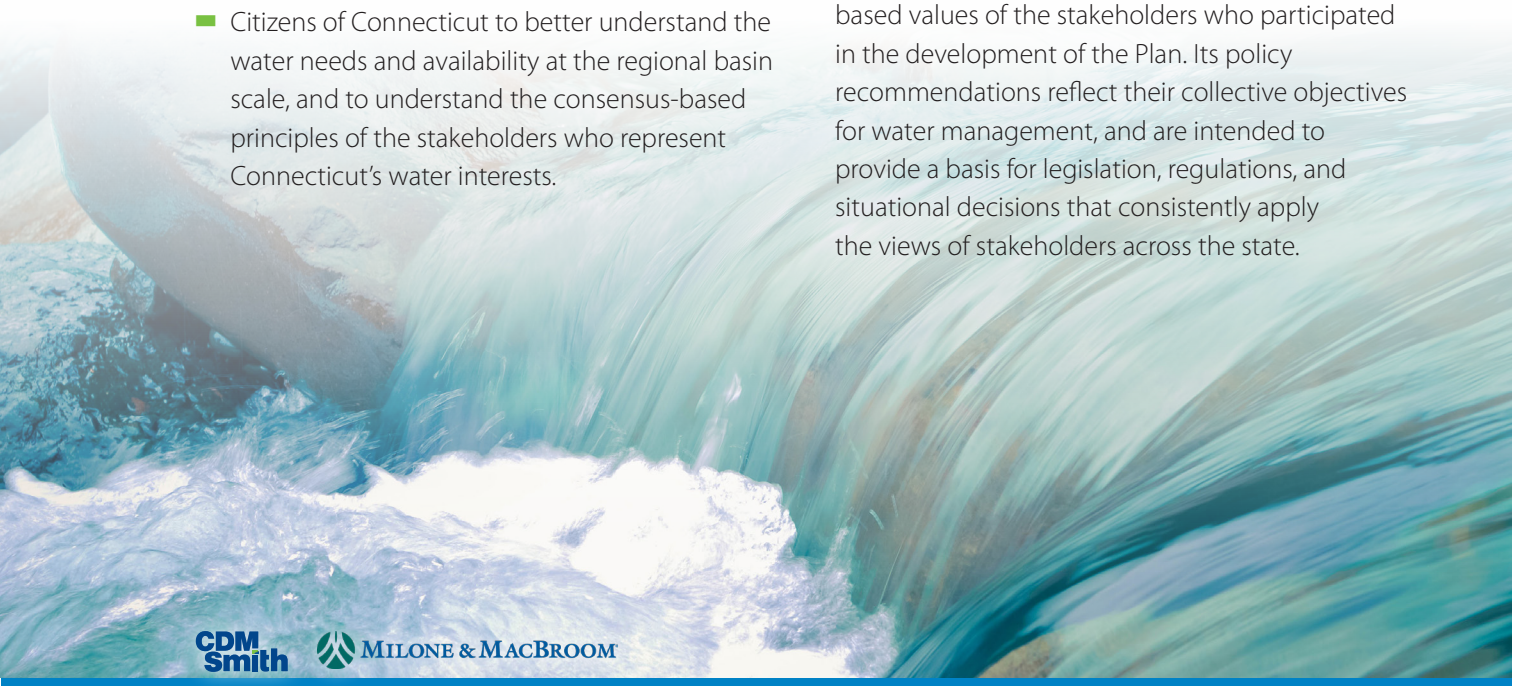
The Plan provides technical information and guiding principles that may be used to inform decisions across the state or on a case-by-case basis. The Plan's information may be used by:

- Lawmakers to collaborate with the Water Planning Council and formulate future legislation
- Regulators to adapt water and land regulations to changing needs and conditions
- Utilities, river basin planning groups, and other water users as a framework for decisions
- The Water Planning Council to inform decisions and recommend legislation.
- Citizens of Connecticut to better understand the water needs and availability at the regional basin scale, and to understand the consensus-based principles of the stakeholders who represent Connecticut's water interests.

The Plan does not attempt to prioritize any particular water use or water use category over others. Likewise, specific uses of water, if currently authorized by state law and regulation, are neither advocated nor diminished relative to other uses, and the Plan does not attempt to resolve site-specific or situational issues.

Specifically, the Plan includes maps and data summary sheets on each of the state's 44 regional river basins and compares water that is naturally available in each basin to the current and future needs for water in and out of the streams. These tools are not definitive statements about the adequacy of water to meet all needs, but rather, they are screening tools to indicate where risk is higher or lower regarding a basin's ability to meet all needs into the future. As such, they have been used (and may continue to be used) to help establish priorities for specific initiatives and future legislation. Examining the balance between water availability and all of the water needs in a basin under average and hydrologically stressed conditions can inform decisions scientifically, establish legislative priorities, and help promote awareness of water as a limited resource. Examples of how to interpret the technical information are included below in this Executive Summary under the heading, "Technical Findings."

Additionally, the Plan is a repository of consensus-based values of the stakeholders who participated in the development of the Plan. Its policy recommendations reflect their collective objectives for water management, and are intended to provide a basis for legislation, regulations, and situational decisions that consistently apply the views of stakeholders across the state.



A Collaborative Approach to Planning

As many other states have discovered, a central tenet to successful planning is the building of consensus for recommendations. Because consensus building is so important to an implementable plan, Connecticut's process included six workshops with stakeholders representing a broad variety of water interests, including (but not limited to) those in the box on the left.

Stakeholders

- State regulatory authorities
- Environmental advocacy groups
- Watershed groups
- Water utilities (public and private)
- Agriculture
- Industry
- Energy
- Golf courses
- Academia and science
- Public health officials
- Council of governments (COGs)
- Wastewater

These stakeholders participated in six facilitated workshops during the planning process, as outlined in the workshop plan shown on the right. These workshops were open to the public, and in addition to facilitated discussions with stakeholders, each workshop allocated time for public comment. The figure also indicates that public outreach is being accomplished through a series of public meetings, during which citizens of the state offered ideas, asked questions, voiced concerns, and engaged in direct dialogue with state officials and the planning consultants.

The workshops, supported also by WPC subcommittee meetings, resulted in consensus on policy recommendations (Section 5), as well as next steps, or "Pathways Forward" on issues for which consensus could not reasonably be achieved within the one-year time frame. The Pathways Forward (also in Section 5) include suggested ways to enhance available information, increase outreach, and establish partnerships to further the collective understanding of water strategies. As these issues mature, the WPC can shepherd them through a formal decision process by which they can result in additional policy recommendations.

A full discussion of the stakeholder and public outreach efforts is presented in Section 4 of this report. Additionally, a State Water Plan Fact Sheet is included as Appendix A. This fact sheet has been distributed at meetings and workshops, and is also available online via the Water Planning Council website (http://www.ct.gov/water).

Facilitated Workshops to Support Plan Development

PHASE I

Workshop #1: Plan Framework
Goals and Water Management Options

Public Meeting Eastern CT | Public Meeting Central CT | Public Meeting Western CT

PHASE II

Workshop #2:
Refinement of Options

Workshop #3:
Policies vs. Pathways

Public Meeting

Workshop #4:
Paths Forward / Decision Framework(s)

Workshop #5:
Policy Recommendations

Public Meeting

Public Meeting

Workshop #6:
Plan Recommendations





Summary of Key Findings and Recommendations

Technical Assessment

Key to making informed decisions about future water management is a sound technical understanding of the condition of Connecticut's river basins, including the amounts of water flowing in each, and the competing demands for this water. This plan does not evaluate each municipality or water utility on its own, but rather, evaluates water availability and use patterns on a regional basis, delineated by the tributary basins to the major rivers in Connecticut. Figure ES-1 illustrates the major basins in the state, and also outlines the 44 regional basins that are tributary to these basins, and for which technical assessments are presented in this report.

Each of the 44 river basins was evaluated for water availability (surface water and potential groundwater recharge), as well as current and future water needs, both out-of-stream and instream. For the purposes of this report, the term "out-of-stream" water use refers to water that is removed from a stream or aquifer, some of which may be returned as wastewater at another location. These are sometimes referred to as "consumptive" water uses. Private residential wells are an out-of-stream water use, and about 23% of the state's population use private residential wells. "Instream" water use refers to water that remains in its natural environment (generally streams or lakes) for ecological, recreational, or aesthetic purposes. Instream uses are also sometimes referred to as "non-consumptive" water uses.

The goal of the technical assessment was to provide a relative basis for determining which river basins may be at risk of not being able to satisfy all instream and out-of-stream needs, either now or in the future. Likewise, the evaluation identified river basins that are likely to have an abundance of water – different management policies may apply to basins with different levels of risk. Figures ES-2 and ES-3 provide an illustrative example of one way in which indicators of

Figure ES-1: Regional River Basins in Connecticut Evaluated in this Plan

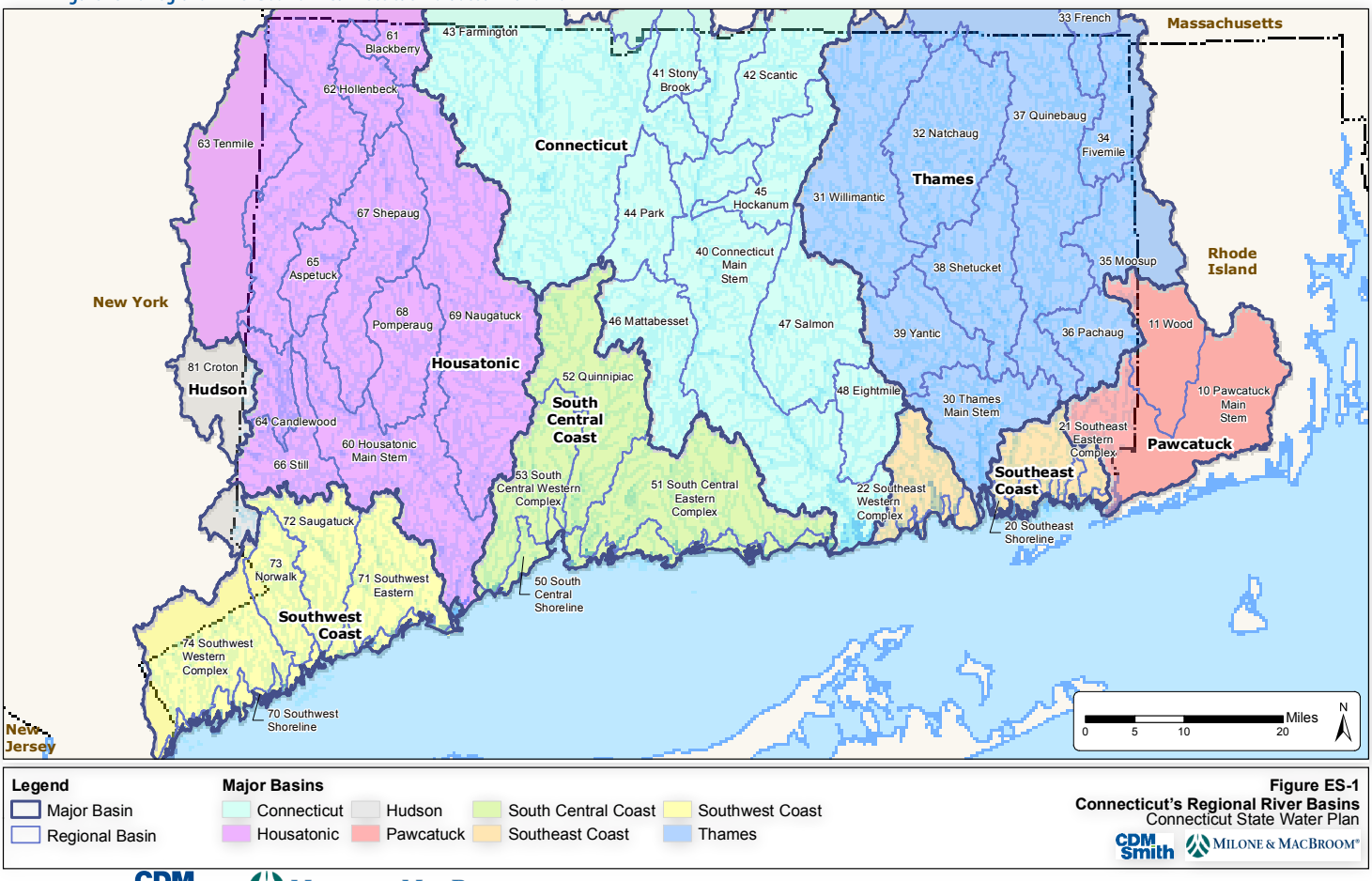
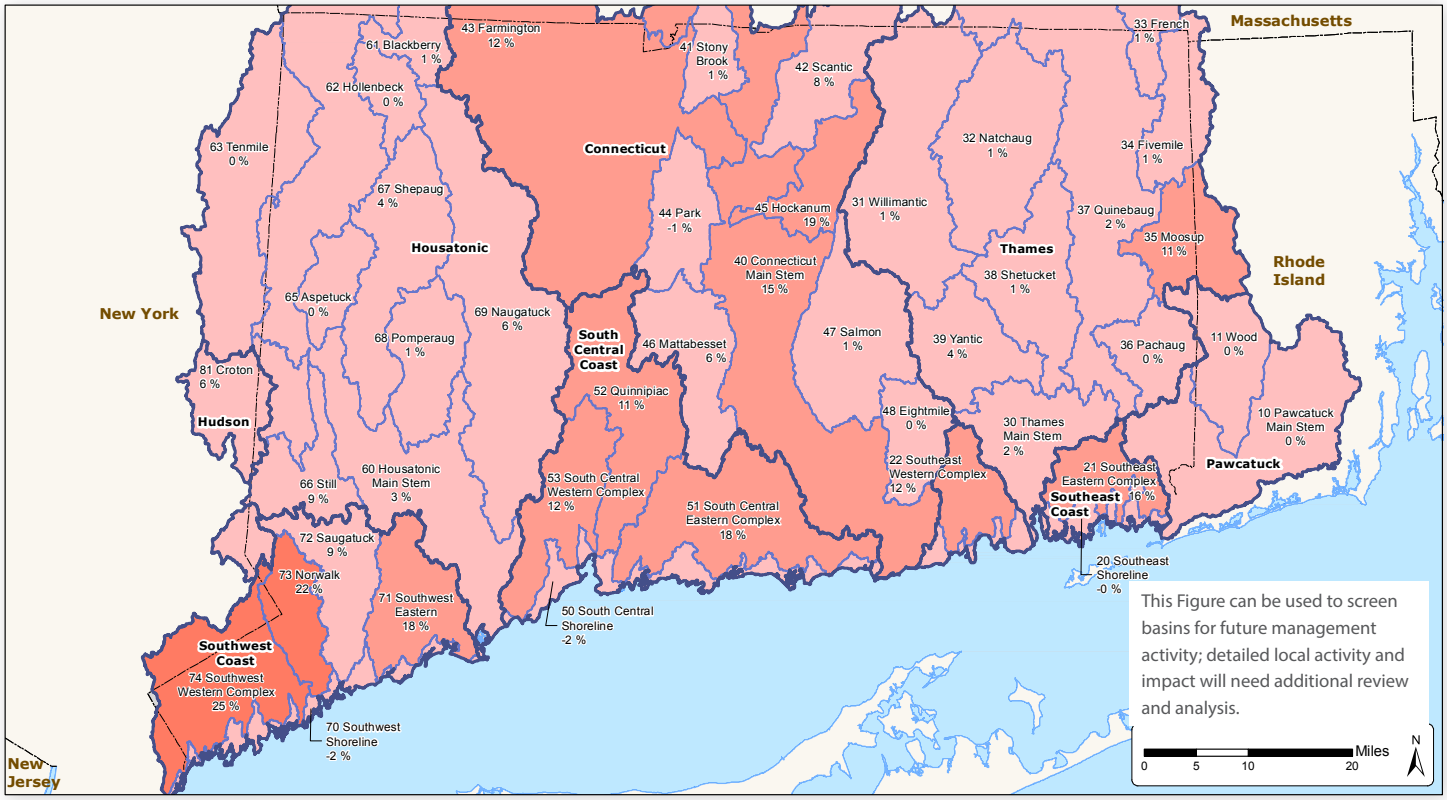


Figure ES-1
Connecticut's Regional River Basins
Connecticut State Water Plan

CDM Smith | Milone & MacBroom

Figure ES-2*: Current River Basin Risk Indicators** - Annual Average Basis

**This also appears in Section 2 as Figure 2-6. ** "Risk" refers to a basin's ability to satisfy water needs, in this case, instream and out-of-stream needs.*



Legend
Major Basin
Regional Basin

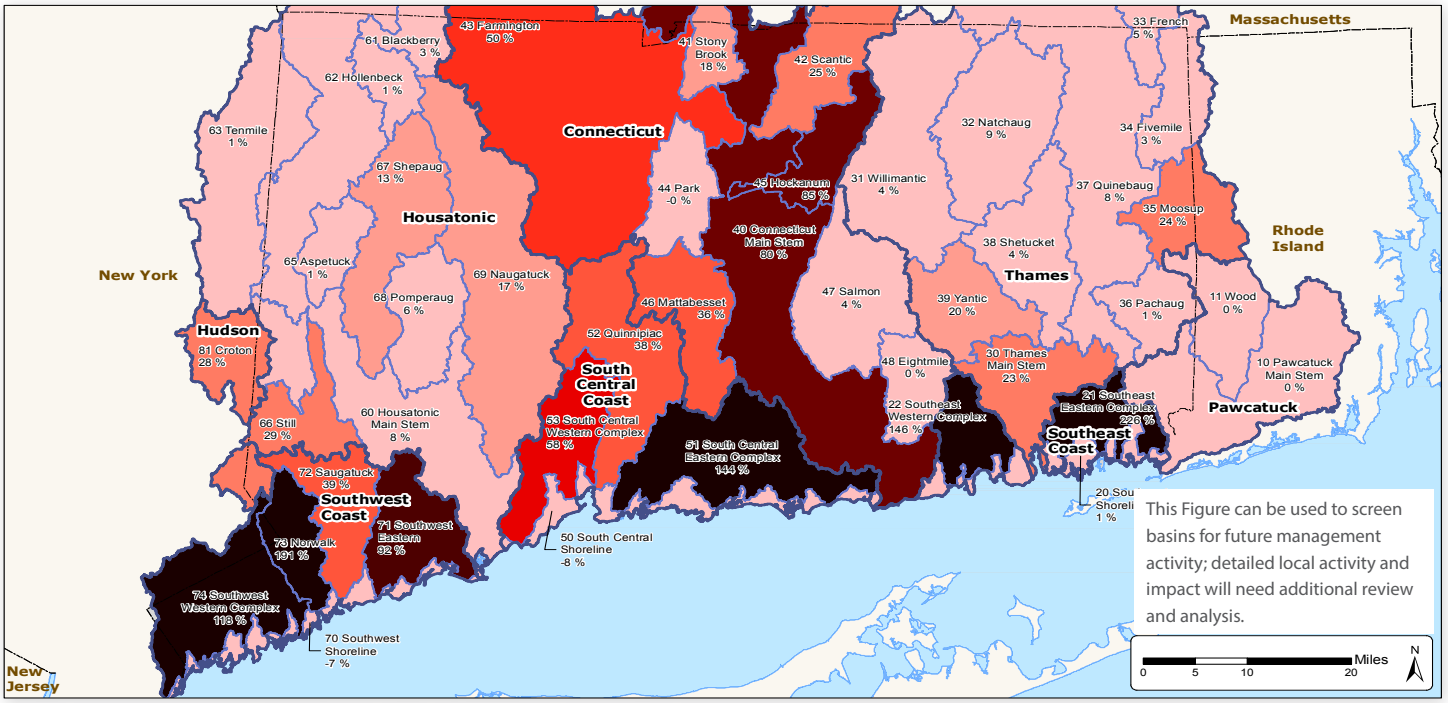
Total water demand as a percent of average annual streamflow (%)
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 -90 | 90 - 100

Figure ES-2
Total Water Demand as a Percent of Average Annual Streamflow
Connecticut State Water Plan

CDM Smith | Milone & MacBroom

Figure ES-3*: Current River Basin Risk Indicators** - Typical Summer Conditions

**This also appears in Section 2 as Figure 2-9, as listed above. ** "Risk" refers to a basin's ability to satisfy water needs, in this case, instream and out-of-stream needs.*



Legend
Major Basin
Regional Basin

Total July water demand as a percent of July streamflow (%)
< 10 | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | > 100

Figure ES-3
Total July Water Demand as a Percent of July Streamflow
Connecticut State Water Plan

CDM Smith | Milone & MacBroom

basin risk are characterized in this report. For planning purposes, this risk is defined as the possibility that a basin may not satisfy all instream and out-of-stream needs under all conditions, and is measured as the percentage of available water for which there is documented demand or need. It does not necessarily suggest that a basin is at risk of overuse, but indicates on a relative basis which basins are using more of their available water than others, and by how much. Figure ES-2 presents a current condition assessment based on annual average statistics, and Figure ES-3 presents a current condition assessment based on typical summer conditions, during which demands are generally higher and natural water flows are usually at their lowest. The report also presents results for year 2040. Detailed studies and river basin models would characterize the dynamics of specific basins in more detail (and the Plan suggests ways of accomplishing this in Section 3 and again in Section 6), but the results in this report can be used to screen basins for management activity based on their relative potential for use and overuse.

These maps clearly indicate that while many basins in the state appear to have plentiful water under average annual and typical summer conditions, other basins may not be able to satisfy all water needs all the time (including both instream and out-of-stream needs). The overarching goal of this Plan is to recommend policies and strategies aimed at improving the balance of meeting these needs under all conditions.

Certain caveats are important when considering the maps of basin risk. **First, the results are generalized to the basin scale, and are not indicative of potential risks to small tributaries, river reaches with localized well fields nearby, or other local subsystems of the basin.** Second, many of the basins contain reservoirs, and stored water can be an effective buffer against the basin's risk of not satisfying all needs under all conditions. To address this in the report, maps of total storage in each basin are included (Figures 2-10 through 2-12), and an example is shown below as Figure ES-4. Third, some basins may include additional water flowing in from upstream basins, whose quality may be suitable for certain non-potable needs and instream needs, but not necessarily all water needs. Fourth, drought conditions are often worse than typical summer conditions, and normal summer risks may be amplified during droughts.

Figure ES-4*: Example Storage Map for July Demand Levels
**This also appears in Section 3 as Figure 3-6.*

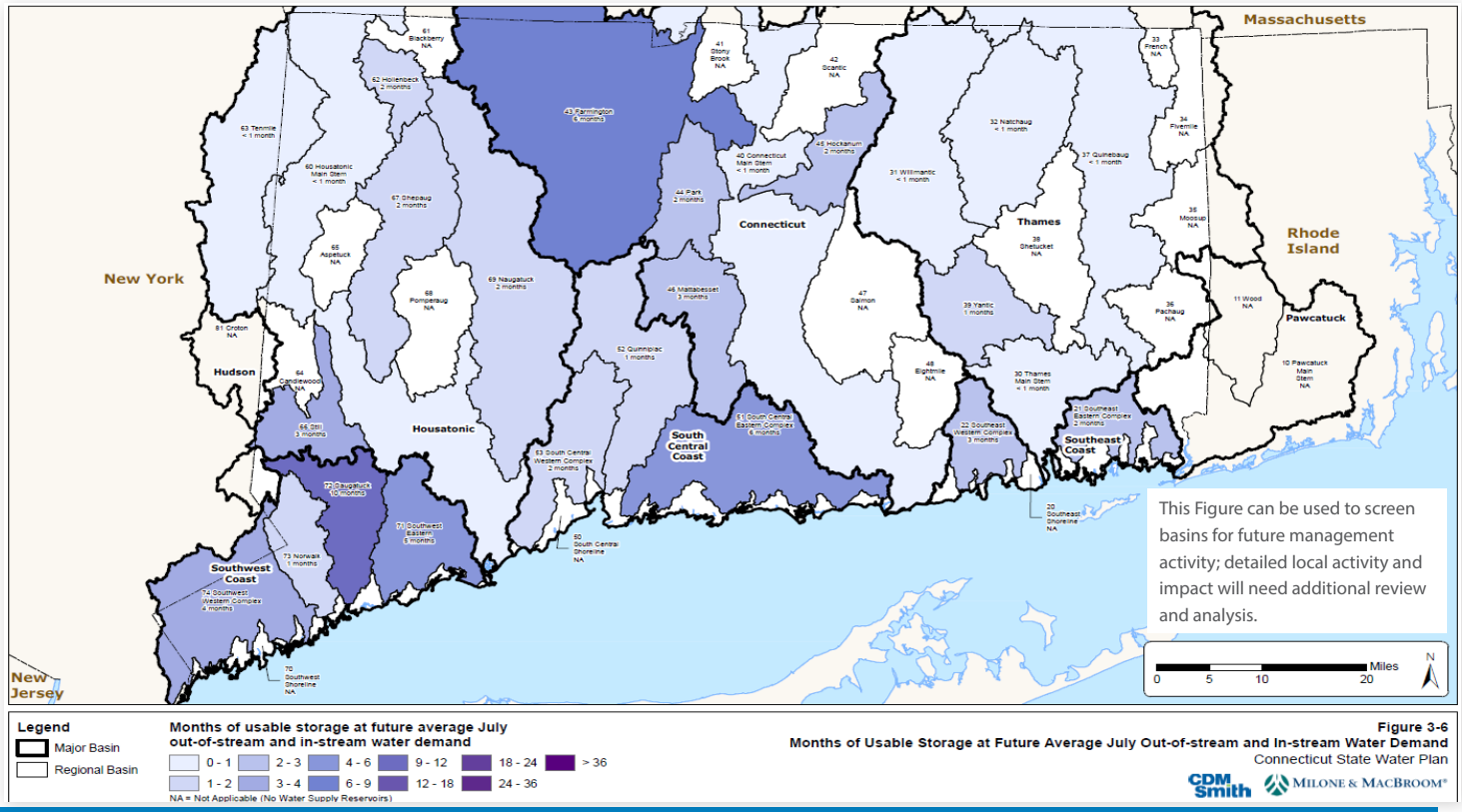


Figure 3-6
Months of Usable Storage at Future Average July Out-of-stream and In-stream Water Demand
Connecticut State Water Plan

Because of these caveats, the maps and diagrams in this report are intended to be used as screening tools only – that is, tools to compare the potential risks in basins relative to each other, but not to definitively determine if or where a river basin may be unable to satisfy all of its water needs.

To help address the fourth caveat above, and to illustrate the water use patterns in each basin in comparison to water available for these uses, basin summary sheets were created for all 44 regional basins in Connecticut. The summary sheets are included in Appendix E, and tabulate and illustrate the available water under average annual, typical summer, and "worst-case" summer conditions, where "worst cast" is approximated as the historical month of July in the past thirty years with the lowest recorded flow. In total, these summary sheets include:

- Water that originates and occurs naturally within the basin
- All documented out-of-stream water uses (water withdrawals from surface water or groundwater)
- All required reservoir releases, historic or pending (site specific)
- Estimated ecological flow needs (basin-wide)
- Unused diversion registrations and permit volumes (water that is administratively allowed to be withdrawn, but has not been taken historically).

An example summary sheet, Figure ES-5 for the Quinnipiac basin, a good example because it

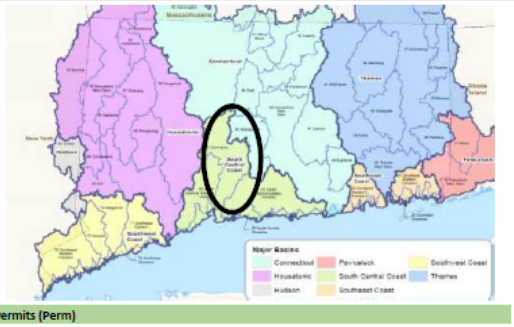
Figure ES-5: Example Basin Summary Sheet for the Quinnipiac Basin

Basin Water Summary

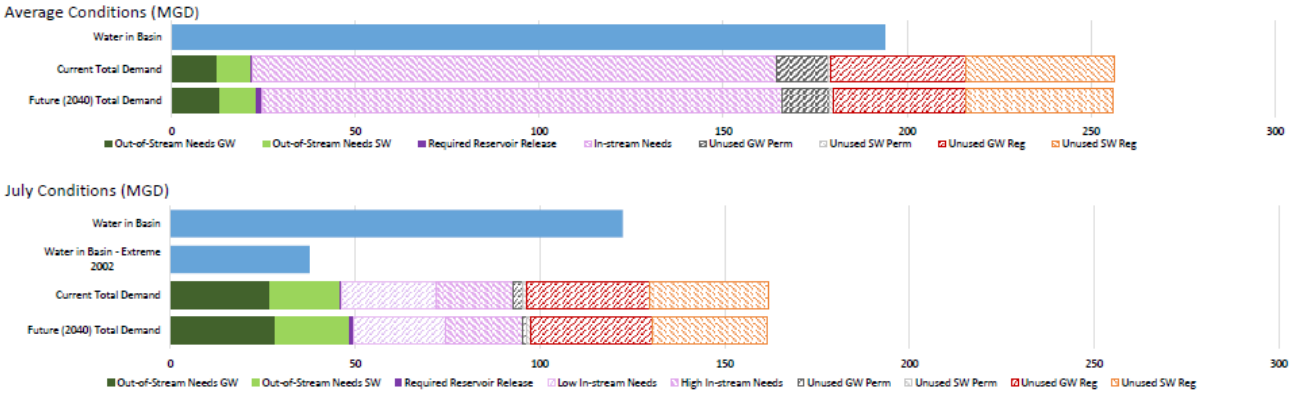
Regional Basin	Quinnipiac
Regional Basin No.	52
Major Basin	South Central Coast
Size of Basin in CT (mi^2)	166

Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	43.7	345	Water In
Wastewater Discharge	3.2	25.1	
Estimated Domestic Recharge	0.5	3.9	
Evapotranspiration	22.8	179	Water Out
Groundwater Withdrawals	2.1	16.3	
Surface Water Withdrawals	1.2	9.3	
Stormflow	12.4	98	Internal
Estimated Potential Recharge (EPR)	12.2	96	
Total Streamflow (Stormflow + EPR)	24.6	194	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	194	12.40	9.35	0.25	143.0		13.61	36.53	1.00	40.52
Future (2040) Conditions, ADD		13.06	9.95	1.40	143.0		12.85	36.30	1.00	40.03
Current Conditions, MMADD	122	27.10	18.88	0.25	26.0	46.9	2.66	33.18	1.00	32.31
Future (2040) Conditions, MMADD		28.50	20.01	1.19	26.0	46.9	1.19	32.73	1.00	31.37

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

includes all of the elements listed above, and demonstrates potential risks under certain conditions. A guide to understanding the summary sheets is included in Appendix E, and the calculations are discussed in Sections 2 and 3.

As an example for how the basin summary sheets can be interpreted, Figure ES-5 illustrates that on an average annual basis, there is sufficient water in the basin to satisfy current instream and out-of-stream needs (solid bars), but that if all unused registrations and permits were exercised in the future, the available water would be insufficient. We can draw the same conclusion for typical summer conditions, but note that for extremely dry conditions (the shortest blue bar), there is not sufficient water even for documented out-of-stream water needs in this basin. This was evidenced during the 2016 drought, during which portions of the upstream river were nearly dry.

These screening tools were vetted using some of the recent knowledge about impacts to river basins during the 2016 drought. Several examples are discussed briefly here:

Quinnipiac River Basin: The maps and summary sheet, discussed previously, suggest a moderate-to-high risk that the Quinnipiac Basin may not be able to support all of its needs during average annual conditions or typical summer conditions. However, there are 1-2 months of storage in the basin that can partially offset concerns about short-term seasonal droughts. The basin summary sheet, however, suggests that during severe drought conditions, there will not likely be sufficient water in the basin even to satisfy all out-of-stream needs (though the tools do not indicate specifically where such problems might occur). Indeed, during 2016, flow in the mainstem Quinnipiac dropped to approximately 1 cfs near the town of Southington.

Pomperaug River Basin: The maps show that under average conditions and typical summer conditions, the Pomperaug River Basin can likely satisfy its instream and out-of-stream needs (requiring ~55% - 65% of naturally occurring water). However, the basin summary sheet for the Pomperaug Basin suggests that during significant drought conditions (similar to 2016), the out-of-stream needs amount to ~80% of available water, and there would not be enough remaining water expected to satisfy instream needs. Indeed, during 2016, anecdotal evidence suggests that certain reaches in the basin were nearly dry. Again, the screening methodology does not pinpoint the location or severity of stream or aquifer depletion, but the tools can be used to identify the relative level of risk under various conditions.

Farmington River Basin: Similar to the Pomeraug, the Farmington Basin shows only moderate risk during average conditions, but the risk rises sharply during typical summer conditions. During severe drought conditions, it is not expected that there will be enough water flowing naturally in the basin to satisfy all needs, or even the out-of-stream needs on their own. However, much of the storage in the state is located in the Farmington basin, and the storage map in Section 3 indicates that the basin can store between 6 and 9 months of supply at expected July demand levels. This would be an effective offset to concern about seasonal drought, though the findings suggest that even this basin could be susceptible to multi-year droughts. And to vet the screening process, most of the basin was sufficiently supplied during the 2016 drought, but (as suggested by the comparison of available water to out-of-stream needs), the Coppermine Brook (a tributary) did run dry in 2016. This is a good example of how the screening tools can be used to indicate the presence of risk, but not pinpoint the specific location, and also to illustrate potential offsets on a spatially-averaged basis.

In summary, Table ES-1 helps explain how many basins in Connecticut may be at risk over the next 25 years of not meeting all of the water needs (again, the "balanced" needs of instream and out-of-stream uses). While generally, the results suggest that most basins can supply adequate and safe drinking water under most conditions (especially with the benefits of storage, which is not accounted for in the table),

Table ES-1: Number of Basins at Risk of Not Satisfying Water Needs*

Hydrology and Demand Conditions (Today through 2040)**	Approximate Number of Regional Basins Potentially at Risk of Not Satisfying Needs (out of 44)		
	Out-of-Stream AND Instream Needs	Out-of-Stream Needs Only	Instream Needs Only
Average Annual	4	0	1
Typical Summer	13	7	1
Severe Drought Month	44***	22	44***
Average Annual, with all unused registered diversions**** exercised	22	15	NA

*This table does NOT account for storage, which can offset short-term seasonal risks significantly

**No major changes in demand are expected between now and 2040. Climate change results suggest only slightly less water availability in the summer, which may be offset by storing projected higher runoff values earlier in the year.

***This does NOT mean that 100% of rivers or river reaches are at risk, but rather, that there may be tributary reaches in each basin that could be at risk.

**** Most water diversions in Connecticut were grandfathered from permitting through a registration process. Registered volumes do not necessarily represent actual overallocation of water as many remain unused or underutilized. Although there may be practical limitations to using their maximum capacity, full use of some unused registrations could put rivers in jeopardy of not meeting all instream and out-of-stream needs. See Sections 5.2.3.7 and 5.3.2.3 for recommendations.

they also demonstrate that some basins may not be able to satisfy all instream and out-of-stream needs in all locations and at all times under all circumstances (potential stress is likely to be localized, and not universal throughout any basins). Further discussion is available in Section 7.

Further technical analysis was conducted to estimate potential ways in which the balance of water needs and water availability could be affected by **climate change** (a future unknown), and by **water conservation** (a way of hedging against known or unknown future conditions, and a consensus-based theme of several policy recommendations in this Plan).

Climate Change: The technical study evaluated the potential range of future climate trends as they could be manifest in monthly precipitation, monthly temperatures, and monthly streamflow throughout the state. Methods and results for all 44 basins are presented in Section 3.1.4 and Appendix F. Again, using the Quinnipiac Basin as an example, Figure ES-6 illustrates an important finding. Results from more than 100 Global Climate Models (GCMs) averaged into four possible future scenarios were used to define the ranges of possible future conditions in Connecticut, and the trends consistently suggested that on average, annual rainfall and runoff will be higher in 2040 than they are today. On a monthly basis, however, changes are distributed throughout the year; Runoff is likely to be significantly higher in the future in winter months, and maybe only modestly lower in summer months. Additionally, the potential for reservoir refill from higher winter runoff could positively affect the reliability of certain water supplies. These results, fairly consistent across the state, suggest that future flood risks could increase, and also serves as a warning of potentially drier summer conditions even though more rain is expected annually. Additional work is recommended to address the following:

Figure ES-6: Example Climate Change Impacts on Runoff in the Quinnipiac Basin by 2040

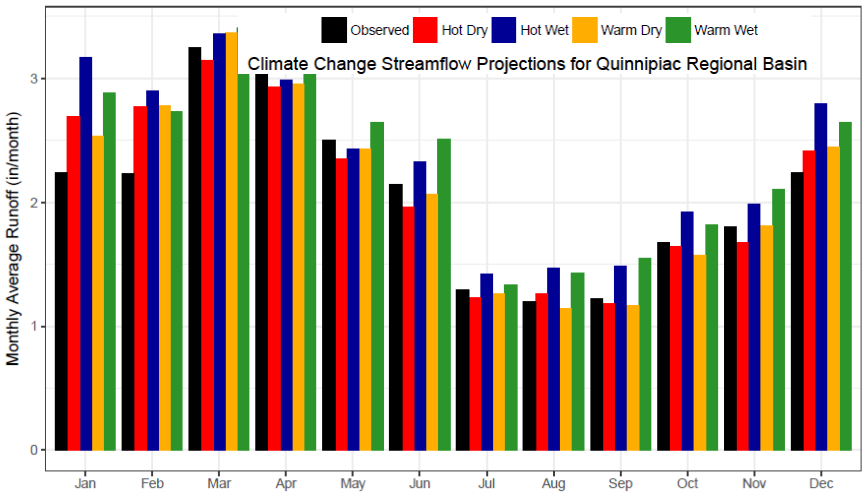
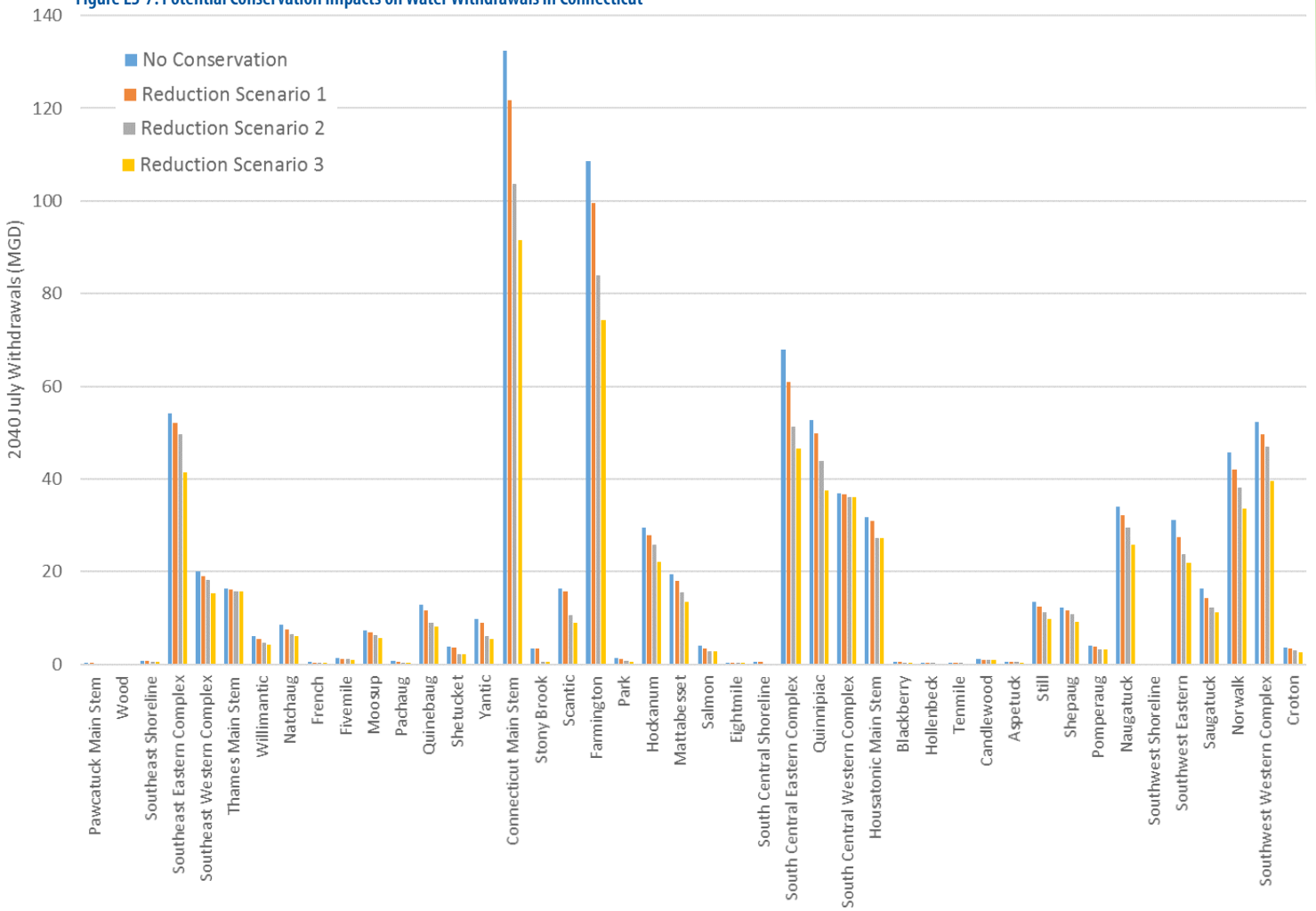


Figure ES-7: Potential Conservation Impacts on Water Withdrawals in Connecticut



- Evaluation of coastal flooding frequency, duration, and depth based on storm surge patterns and sea level rise.

- Evaluation of potential impacts to water supply in specific basins known to be at risk of not satisfying all future water needs (per the information in this report).

- Evaluation of potential longer-term climate trends, extending 50 or 100 years into the future – not as predictions, but as a way to bound the ranges of possible conditions for which adaptive and preemptive measures can be taken.

- Follow a growing nationwide trend of formulating preemptive responses to ANY future climate trend (sometimes referred to as "no regret" decisions), which will yield benefits regardless of the way the climate trends at low cost and low risk. Examples may include system-specific drought indicators, early warning systems for floods, incentives for green infrastructure to promote recharge, reduce runoff peaks, and help control nonpoint source pollution.

Water Conservation: The technical analysis also estimated upper bounds on expected opportunities to conserve water in each basin, based on basin demographics, historic use patterns, and national standards for potential water savings over time through fixture replacement, tighter plumbing codes, and active response to drought conditions in the summer. Results are presented and discussed in Section 3.1.3. Figure ES-7 illustrates upper limits of potential reductions in water withdrawals for out-of-stream uses under three potential conservation scenarios; current federal guidelines for indoor water conservation (Scenario 1), aggressive conservation measures for indoor water use (Scenario 2), and

aggressive indoor conservation measures coupled with 20% reduction in outdoor water use in the summer (Scenario 3). Results suggest that water conservation could be an effective management tool to improve the balance between instream and out-of-stream water uses in basins where this balance may be difficult to achieve. The analysis focused only on household water conservation, and did not attempt to estimate savings in other uses, such as industrial, energy, agriculture, etc.

Policy and Water Management Background

To establish a platform for the recommendations in this Plan, Sections 2.2 and 3.2 of this report offer overviews of current programs, initiatives, regulations, and responsibilities for water management in Connecticut, as well as options for future water management strategies and the challenges that must be overcome. These overviews, originally presented and posted to the WPC website as individual white papers, are provided both to help educate readers, and to help evaluate how future water management can best be accomplished. Section 2.2.1 offers insight into the following:

- The roles and responsibilities of the four state entities who collectively manage and regulate water in Connecticut (DEEP, DPH, OPM, and PURA), as well as areas of overlap in their responsibilities. Like many states, Connecticut relies on more than one agency to regulate water management activities. The current regulatory framework for water management includes certain roles that function toward different objectives, and toward the overarching goal of the Plan, which is to satisfy all current and future water needs.
- The structure of the Water Planning Council and its supporting committees and work groups, all of whom are tasked with orchestrating the development of the State Water Plan
- Current water management programs in the state and the organizations responsible for their oversight.

This report also describes current land management practices and how they relate to water policies, watershed protection, aquifer protection, etc. Section 2.2.2 is devoted to this topic, as a platform from which to evaluate future management opportunities. Ultimately, water and land management policies are intrinsically linked in Connecticut: some water management policies and programs affect land management, and some land management policies and programs affect water management.

Section 3.2.1 offers an overview of the water management options identified by statute and by stakeholders for consideration in future decisions (see Table ES-2). Coupled with these options are the challenges that Connecticut will face when deciding upon and implementing new water strategies, and these challenges are discussed as contextual background in Section 3.2.2, and listed below in Table ES-3.

Table ES-2: Future Water Management Options to Help Achieve the Plan's Goals

Category	Options
Policy and Planning Options	Land use practices and protection
	Water conservation, incentives, rate structures
	Incorporation of existing local and state plans, such as water supply, energy, land conservation, etc.
	Regionalization of water supply and appropriate interconnections
	Identify funding mechanisms for Plan implementation and updates
	Develop monitoring plan for Plan implementation
	Statewide drought planning and mechanisms to enforce water restrictions
	Future Class B water for non-potable uses
	Water use accounting
	Groundwater and private well monitoring and protection
Technology Options	Technology and facility improvements/replacement
	Water Reuse and Greywater use
	Wastewater management
	Stormwater management
	Desalination
	Flood management
	Leak detection
	Real-time flow monitoring
Regulatory Options	Address registered diversions
	Implement instream flow regulations
	Changes to laws / regulations
Outreach Options	Public Education – Short and Long Term

Table ES-3: Future Water Management Challenges

Overarching Challenges Inherent in the Connecticut Regulatory Framework* (Section 1 of this Report)	Challenges Unique to Certain Water Uses or Sectors* (Section 2 of this Report)
Connecticut's Established Home Rule	Water Allocation (registered diversions, small unreported uses, etc.)
Levels of Authority during Plan Implementation	Adoption of Instream Flow Requirements as an Ecological Water use
Connecticut's Prohibition of Class B waters for human consumption	Public Water Supply Issues (Coordination with WUCC process, Barriers to regionalizing small supplies, changes in future consumption)
Public Perception and Uncertainty (including lack of a "conservation ethic" in Connecticut)	Watershed and Groundwater Protection Where Incentives are Lacking
Funding Constraints	Water System Vulnerabilities and Security Issues
Data Gaps	The Food-Energy-Water Nexus
Understanding Economic Impacts	Emerging Contaminants
	Aging Infrastructure
	Funding for Water Reclamation
	Constraints on Water and Sewer System Expansion

*The Challenges are not presented in any specific order of importance, and this report explains that many of these challenges also have beneficial histories that will extend into the future for the benefit of Connecticut's citizens and environment.

New Policy Recommendations

With the above information as background, stakeholders formulated policy recommendations aimed at guiding future legislative, regulatory and planning decision for water throughout the state. These recommendations do not solve all of Connecticut's water problems, nor do they elevate or diminish the value of any particular water use relative to other uses. Rather, these policy recommendations should become guiding principles in future decision making for:

- Future water legislation
- Future regulations on water allocation and management
- Future decisions on specific water projects
- Future activities to help keep Connecticut's water planning process thorough, consistent and data-driven

The policy recommendations in this plan are presented in Section 5.2. They were drafted, reviewed, revised, and agreed upon by the WPC Policy Subcommittee under the guidance of the Plan's consulting team. They were all drafted in response to stakeholder directives from the series of workshops conducted during the one-year planning process. Their themes are listed in no particular order of priority or importance, and include the following:

- Land Use Practices and Protection Related to Water
- Water Quality Impacts of Land Use
- Water Conservation
- Consistency with Existing State Plans (for example, the State Plan of Conservation and Development)
- Monitoring for Plan Implementation
- Agricultural Practices
- Unused Registered Water Diversions
- Implementation of Minimum Stream Flow Regulations
- Outreach, Education and Public Engagement
- Regionalization of Water
- Class B Water for Non-Potable Use
- Data
- Coordination with Water Utility Coordinating Committees (WUCCs)

A separate policy paper was drafted for each of these themes (See Section 5.2.3). Each paper includes many specific recommendations, from which the Policy Subcommittee culled the following suggestions as the most important policies for focus within the next several years as the Plan is introduced:

Top 10 Consenus-Based Policy Recommendations:

1. Water management should follow scientific examples.
2. As possible, remove obsolete water registrations.
3. Encourage innovation in agricultural water practices.
4. Water data (or access to it) should be centralized in a single database and/or portal to other sources.
5. Consider Class B Water for individual non-potable uses if environmentally prudent and cost-effective, using guidelines to be developed by the WPC for review of Class B water for non-potable uses using the Triple Bottom Line philosophy (environmental, social, and economic metrics).
6. Develop an education and outreach strategy focusing on water conservation topics.
7. The WPC should provide ongoing review of other Connecticut state plans in order to identify and address inconsistencies.
8. Encourage regional water solutions where they are practical and beneficial.
9. Reaffirm support for the protection of Class I and II land contributing to water supply. Expand protections to other watershed lands and land that feeds aquifers used for public water supply or by private wells.
10. Create a data-based water education program aimed at the general public and municipal officials.

Pathways Forward for Continuing Discussion

Not all water issues were resolved (or expected to be resolved) by stakeholder consensus during the one-year planning process. Those that were are listed and explained with policy recommendations in Section 5.2. Issues for which consensus requires additional work before recommending policies that are mutually agreeable to the Water Planning Council member agencies and their stakeholders are discussed in Section 5.3.

Planning is an ongoing process. Many issues identified by the State Water Plan statute or by stakeholders during the planning process yielded productive dialogue, but not necessarily a clear consensus on policy recommendations. Rather, needs were identified for additional information, possible partnerships, and opportunities for facilitated consensus-building before recommendations can be made with broad stakeholder support. For each of these issues, the State Water Plan has prepared a series of Next Steps, or "Pathways Forward," which are intended to help the WPC and its stakeholders advance each unresolved issue closer to consensus. Even if consensus cannot be fully achieved, these next steps could help educate decision makers on the benefits and disadvantages of future water management strategies, so that legislative and regulatory decisions can be more informed than they would be today.

The next steps are offered as suggested ideas, to be advanced or initiated at the discretion of the WPC based on its priorities and available resources. None of the suggestions are mandates or requirements, and they do not represent recommendations for changes in policies, laws, or regulations. They are intended to serve only as menus of ideas that can improve the clarity with which the WPC advances (or elects not to advance) these issues in the future.

For each issue that requires additional steps if consensus is to be reached, the Pathways Forward include 3 types of recommendations:

- **Additional Information Needs –** intended to provide stakeholders with more complete data, opinions, case studies, and impact assessments with which to continue the dialogue.
- **Possible Partnerships –** which may provide both an impetus and a mechanism for accomplishing fact-finding, pilot studies, or even implementation of progressive water management techniques.
- **Opportunities for Consensus Building and/or Communication –** intended to gather public input and support, or facilitate formal dialogue between stakeholders or interested participants in an implementation effort.

Unlike the policy recommendations, where the intent is for the legislature to adopt the draft policies as guiding principles for future laws and regulations, these next steps are suggested opportunities specifically for the Water Planning Council. As needed, legislative authorization and/or funding may be needed to take certain steps. In other cases, the intent of these steps is that they be implemented under the authority and discretion of the Water Planning Council. They are intended to serve as reasonable opportunities that the Water Planning Council could undertake in the future to clarify certain issues or draw stakeholders closer to consensus for future policy recommendations.

Some of the issues that require further information and outreach are also included in the recommended policies. This is because the approach to certain aspects of these issues was agreeable to the stakeholders, while other aspects require more time and information. The list of Pathways Forward topics, included in Section 5.2, are listed in Table ES-4.

Table ES-4: Categorization of Pathways Forward

Theme	Category	Specific Options and Challenges
Water Management Options	Policy and Planning	Conservation and Incentives
		Regionalization and appropriate interconnections
		Identify funding mechanisms for Plan implementation
		Statewide drought planning
		Future Class B water for non-potable uses
		Water use accounting
		Groundwater and private well monitoring and protection (grouped with Watershed/Aquifer protection, below)
	Technology	Technology and facility improvements/replacement
		Water Reuse and Greywater Use
		Wastewater management (combined with Reuse, above)
		Stormwater management
		Desalination
		Flood management
	Regulatory	Address registered diversions
		Changes to laws / regulations
Future Challenges	Inherent in CT Reg. Structure	Levels of authority for implementation
		Understanding Economic Impacts
	Specific to Certain Uses	Watershed/aquifer protection where incentives are lacking
		Vulnerability and security issues
		Food-Energy-Water Nexus
		Emerging contaminants
		Aging infrastructure
		Constraints on system expansion
		Climate Change
		Water Quality Impairments

- Developed with Stakeholders (Section 5.3.2.1)
- Developed with WPC (Section 5.3.2.2)
- Grouped into "Overcoming Future Challenges" (Section 5.3.2.3)
- Grouped into "Technology Issues" (Section 5.3.2.3)

Plan Implementation

Lastly, Section 6 of the Plan offers guidelines for implementation. These include an enabling framework that allows the WPC to make decisions on recommending or implementing next steps, seek funding, and formulate new policy recommendations for legislative or regulatory consideration. The guidelines also offer suggestions for ways in which the WPC can effectively work to resolve ongoing water conflicts in the future, whether the conflict is localized or universal throughout the state.

Funding

Section 6 also provides a comprehensive list of possible funding sources for Plan Implementation, including both state and federal programs and their potential relevance to the recommendations in this Plan as it moves forward. A table of examples is also provided, which shows how specific recommendations for water conservation may qualify for certain funding programs.

Tracking Progress

Section 6 also offers guidelines for tracking the implementation of the Plan against its own goals and the 17 requirements of the originating statute (see earlier text box). The Plan addresses in some way all 17 of the requirements, but full satisfaction of the intent of the statute will come partially through the implementation phases of the Plan, not just the planning process to date. To enable this, the Plan should serve as a unifying platform for scientific information, guiding principles, and roadmaps toward consistent future decisions.

Future Roles of the Water Planning Council

To date, the Water Planning Council has been tasked by statute to oversee the development of the State Water Plan. To effectively implement the Plan by promoting consistent use of its data and recommendations, the WPC has proposed that its future roles include:

- Early Review of Proposed Water Legislation: WPC can help move legislations forward in three ways:
  - Offer consensus support from the four member agencies
  - Suggest clarifications using the Plan's information
  - Recognize potential conflicts or disagreements early so that they can be addressed
- Develop proposed legislation as needed
- Hire a Water Plan "Chief" to oversee the implementation of the Plan and serve as a liaison between the WPC, public, and legislature.
- Offer three forms of conflict avoidance and resolution:
  - Mediation using a non-regulatory appointee
  - Non-binding arbitration for willing parties
  - Binding arbitration for willing parties or as deemed necessary by the legislature
- Seek and secure funding for the Plan's recommendations
- Prioritize and initiate next steps outlined in the Plan
- Potentially add a fifth non-regulatory member to the WPC to avoid tie votes
- Obtain statutory authority as necessary for:
  - Implementation when funding is available,
  - Appointment of a mediator and a Water Plan Chief
  - Arbitration authority at the discretion of parties in conflict.
- Continue to oversee the subcommittees if necessary (the Water Planning Council will determine the necessity and frequency of meetings for the Policy and Science and Technical Subcommittees, though the Advisory Group will continue forward, likely with additional members):
  - Policy Subcommittee, on issues pertaining to future legislation and additional policy recommendations that may result from future consensus building

- Science and Technical Subcommittee, on issues related to basin evaluation and modeling, counsel on data collection, use, and access, etc.
- Advisory Group, on issues pertaining to Plan Implementation

Possible Legislation

The Plan does not recommend specific legislation, but its policy recommendations are intended to help formulate consistent future legislation aimed at preserving and improving the balance of water uses throughout the state. Several examples of potential legislation that stakeholders envision might arise from the implementation of the Plan include:

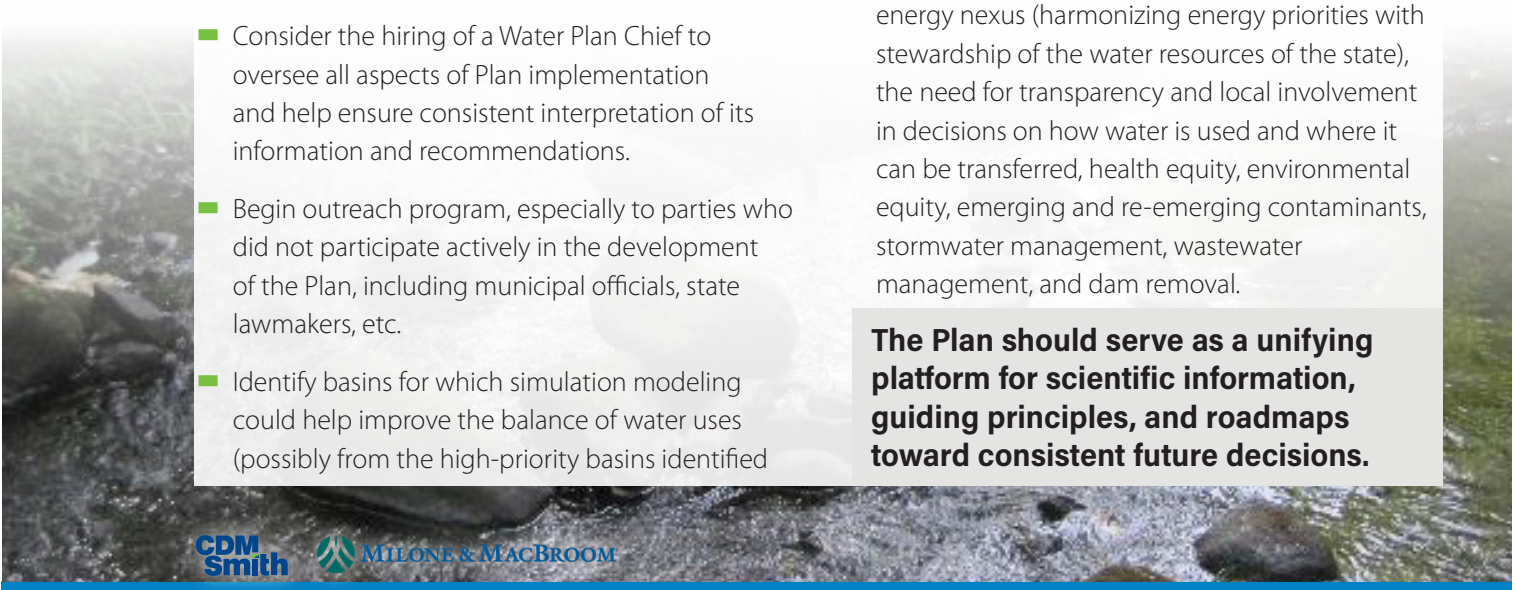
- Retiring obsolete diversion registrations determined not to be needed now or in the future
- Water conservation laws or incentives in concert with ongoing utility initiatives
- Private well testing program
- Statutory authority for the Water Planning Council, as outlined above

Near-Term Steps (within the first several years)

The Plan recommends the following near-term steps toward implementation (suggested within the next few years, but clearly dependent on available time and resources):

- Consider the hiring of a Water Plan Chief to oversee all aspects of Plan implementation and help ensure consistent interpretation of its information and recommendations.
- Begin outreach program, especially to parties who did not participate actively in the development of the Plan, including municipal officials, state lawmakers, etc.
- Identify basins for which simulation modeling could help improve the balance of water uses (possibly from the high-priority basins identified in the Plan), and identify funding mechanisms for initiating basin studies. A recommended tool (SWAM) or similar software modeling tools, as well as an example of how simulation modeling can effectively evaluate state-wide policies within the regional basins at a more local level is included in Section 3.1.6).
- Consider the establishment of volunteer River Basin Commissions (as needed, and only where existing basin-wide groups, regional planning authorities, or COGs do not purport to function at the desired scale) to prioritize local issues in river basins and apply the data and principles in the Plan to recommend action to the WPC (following examples from other states)
- Formulate plans for centralized data portal and assign this to a specific agency or organization
- Seek funding for policy recommendations that require financial support (outreach, data collection and consolidation, etc.)
- Review the Plan recommendations to determine if and when to propose specific legislation. This may involve briefings with law makers and/or collaborative working sessions.
- Consider the topics outlined in Section 6 that are not covered heavily in the Plan, but which the WPC should discuss among the overall priorities in the near term. These topics include components brought up during the public comment period ending in November 2017 and include the water-energy nexus (harmonizing energy priorities with stewardship of the water resources of the state), the need for transparency and local involvement in decisions on how water is used and where it can be transferred, health equity, environmental equity, emerging and re-emerging contaminants, stormwater management, wastewater management, and dam removal.

The Plan should serve as a unifying platform for scientific information, guiding principles, and roadmaps toward consistent future decisions.



Section 1
Introduction

1.1 Explanation of The Final Report

Development of the Connecticut State Water Plan ("the Plan") was divided into two 6-month phases. The January 2017 Phase I report was an interim report at the conclusion of Phase I, which discussed the work and decisions of the first 6 months of Plan development, including a description of current policies, water management structure, water availability now and for the next 25 years, the challenges associated with these components, and the opportunities for enhanced water management in the future. The information presented in the January 2017 Phase I Report served as a platform for making informed decisions on future water management during the following 6 months of the planning process (Phase II), and beyond.

The June 2017 Final Draft State Water Plan includes the information developed in Phase I and Phase II of the Plan development. Phase II efforts included technical analysis, policy recommendations and pathways forward, and recommendations for water management structure and decision framework. Following approval by the Water Planning Council (WPC), the Final Draft was used by the WPC during the public comment review period and public outreach activities.

This Final Report dated January 2018 finalizes the Plan for the WPC to submit to the Connecticut General Assembly. It has been modified to reflect WPC review and discussion following the 120-day public comment period held between July 20 and November 20, 2017.

1.2 Public Act 14-163: Origins of the State Water Plan

On July 1, 2014, Public Act 14-163, "An Act Concerning the Responsibilities of the Water Planning Council," became effective in the State of Connecticut. The Act directs the Water Planning Council (WPC) to develop a State Water Plan in accordance with 17 specific requirements:

> *"Not later than July 1, 2017, the Water Planning Council, established pursuant to section 25-33o, as amended by this act, shall, within available appropriations, prepare a state water plan for the management of the water resources of the state."*

The WPC, comprised of representatives of the four state agencies with oversight or regulatory responsibility for water management (see Section 1.4.1), responded by reviewing methods by which other states had developed statewide water plans, evaluating current practices, future challenges, and opportunities within Connecticut's water management framework, and focusing the work of its Policy Subcommittee, Science and Technical Subcommittee, and Advisory Group on the elements and outline of the Plan. In May of 2016, the WPC, acting through the New England Interstate Water Pollution Control Commission (NEIWPCC), contracted with CDM Smith and subconsultant Milone and MacBroom to provide professional consultation and facilitation services throughout the development of the Plan.

The scope of the Plan includes current assessments of water policy, water availability, quality, and use patterns; future projections of water needs[1] and availability due to changes in climate, demand, and regulations; and evaluation of numerous management options to help satisfy the state's out-of-stream and instream water needs for the next 25 years. It was informed by the WPC's research into processes used by other states to develop statewide water plans (through the work of a work group established specifically for this purpose), and by the 17 requirements listed in the statute. The 17 requirements are as follows with brackets showing scope differentiation from statute text:

1. *"Identify the quantities and qualities of water that [could be available to specific areas under feasible distribution] are available for public water supply, health, economic, recreation and environmental benefits on a regional basin scale considering both surface water and groundwater;*

2. *Identify present and projected demands for water [for specific areas] resources on a statewide and regional basin scale;*

3. *Recommend the utilization of the state's water resources, including surface and subsurface water, [for their greatest benefits] in a manner that balances public water supply, economic development, recreation and ecological health;*

4. *Recommend steps to increase the climate resiliency of existing water resources and infrastructure;*

5. *Make recommendations for technology and infrastructure upgrades, interconnections and such major engineering works or special districts which may be necessary, including the need, timing and general cost thereof;*

6. *Recommend land use and other measures, including an assessment of land acquisition or land protection needs, where appropriate to [insure] ensure the desired quality and abundance of water and to promote development in concert with available water resources;*

7. *Take into account desired ecological, recreational, agricultural, industrial and commercial use of water bodies;*

8. *Inform CT residents about the importance of water resource stewardship and conservation;*

9. *Establish conservation guidelines and incentives for consumer water conservation with due consideration for energy efficiency;*

[1] Throughout this plan, "water needs" include both out-of-stream and in-stream needs. While these terms can have many meanings, in this context "out-of-stream water" needs include any water use that requires the removal of water from a stream or aquifer, even if some or all of it is returned at a downstream location. "In-stream" needs refer to water that remains in place (usually in a stream channel) to serve ecological, recreational, or aesthetic purposes. The Plan does not prioritize out-of-stream and in-stream needs over each other, but considers them to be equal "demands" for water from the available resources.

10. *Develop a water reuse policy with incentives for matching the quality of the water to the use;*

11. *Meet data collection and analysis needs to provide for data driven water planning and permitting decisions;*

12. *Take into account the ecological, environmental, public health and safety and economic impact that implementation of the state water plan will have on the state;*

13. *Include short and long-range objectives and strategies to communicate and implement the plan;*

14. *Seek to incorporate regional and local plans and programs for water use and management and plans for water and sewerage facilities in the [statewide] state water plan;*

15. *Promote intra-regional solutions and sharing of water resources;*

16. *Develop and recommend strategies to address climate resiliency including the impact of extreme weather events; and*

17. *Identify modifications to laws and regulations that are necessary in order to implement the recommendations of the state water plan."*

These 17 goals and considerations represent both objectives for the Plan and some of the means by which these objectives might be achieved. Because they represent different aspects of the planning process, they were divided into two categories during a facilitated workshop as part of the Planning Process in September 2016. Section 1.4.2 describes how the list of 17 goals and considerations was divided into Plan Objectives and Options for Achieving the Objectives. In this way, the list in the statute became the overarching framework for water planning. It has been used to support the first two workshops, and ultimately the plan's recommendations will be assessed against this list.

The statute also specifies the timeframe for completing a draft of the Plan for submittal to the State Legislature:

> *"Not later than January 1, 2018, the Water Planning Council, in accordance with section 11-4a, shall submit the state water plan to the joint standing committees of the General Assembly having cognizance of matters relating to the environment, public health, planning and development and energy and technology for said committees' approval, revision or disapproval, in whole or in part. The council shall submit such report to the Governor electronically."*

The remaining sections of this report describe the results of the planning process and outline the efforts completed to produce this draft Plan in accordance with the directive above.

1.3 Goals and Mission Statement

As part of preparing the request for proposals (RFP) for the State Water Plan Project, the WPC and its supporting committees and work groups prepared a mission statement for the project. As included in the annotated table of contents included in the February 9, 2016 RFP, the mission statement reads:

> *A state water plan using science, data and public input to provide for the utilization of the state's water resources in a manner that balances public water supply, economic development, recreation and ecological health in accordance with the provisions of Section 22a-352 of the Connecticut General Statutes, as amended by Public Act 14-163 by the statutory deadline of July 1, 2017.*

Section 1.2 of this Plan lists the 17 goals and considerations as listed in the statute. As part of Workshop 1 held on September 29, 2016, those goals and considerations were discussed and draft synopsis and summary goals were articulated by consensus. At Workshop 2 held on November 17, 2016, the synopsis and summary goals were reviewed with consensus of the summary of high-level plan objectives as follows:

Synopsis: Provide balanced water use for all needs.

Soundbites (not prioritized)

- *Provide reliable and resilient supply for all uses*
- *Promote public health and quality of life with high quality water*
- *Protect the environment*
- *Manage water cost-effectively for all users*
- *Develop an implementable plan*
- *Prepare for uncertain future climate*
- *Use science and data to recommend action*
- *Involve Connecticut citizens in water management*

A full, detailed list of the goals, both for the development of the Plan and ultimately for its effectiveness, is included in Section 6 of this report.

1.4 Overview of the Planning Process

1.4.1 Water Planning Council and Work Groups

This planning process builds on the prior work and collaboration of the WPC and its supporting committees and work groups. **Figure 1-1** below illustrates the structure of these various groups, which collectively represent a broad cross-section of water stakeholders in the State of Connecticut, including (but not limited to) water utilities (public and private), environmental advocacy groups, watershed organizations, state regulatory and oversight entities, agriculture, Native American tribes, energy, industry, golf courses, and technical water professionals from academia and government agencies.

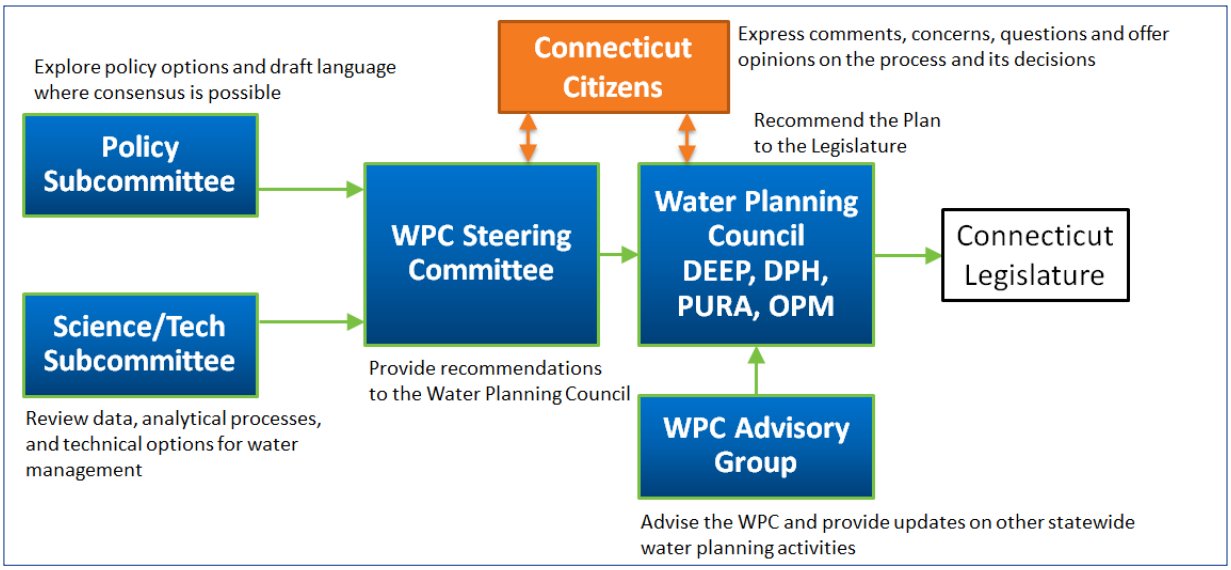


Figure 1-1. WPC Structure and Responsibilities of Working Groups

Ultimate decision responsibility rests with the 4-member WPC, whose members represent the four state entities with purview over water management. These four members will ultimately determine what the Plan recommends, and how, and will present the Plan to the Connecticut Legislature by January 1, 2018.

Supporting the WPC directly are two groups; the WPC Steering Committee (WPCSC) and the WPC Advisory Group (WPCAG). Two subcommittees were developed to assist the Steering Committee, the Policy Subcommittee and the Science and Technical Subcommittee. Among other responsibilities, the WPC Steering Committee and the WPC Advisory Group coordinated with work groups to examine specific issues pertinent to preparations for this planning process, including a work group to explore how other states have accomplished their statewide planning efforts, and a work group to help select a consultant and formulate the scope of the Plan. The WPCSC met regularly to advise the WPC on procedural aspects of the planning process, as well as on relevant issues and other statewide initiatives.

The WPC Advisory Group also meets regularly to help clarify issues within the Plan's framework, and advise the WPC on other significant water initiatives in the state, including the Water Utility Coordinating Committee (WUCC) process, and the Drought Management Plan. Part of the planning process will be to create awareness and take steps if the objectives of the WUCC process and the Plan begin to diverge in any significant way. Note: Statute 22a-352 requires the WPC to consider the WUCC plans.

The Policy Subcommittee responsibilities include identifying challenges in meeting the objectives of a statewide plan, as well as drafting preliminary policy guidelines where there appears to be general consensus among the group members. This work has helped formulate the process for Phase II of the Plan, in which water management options and challenges that can be readily agreed upon can be described with draft policy recommendations.

Likewise, the Science and Technical Group has examined and discussed prior scientific studies on water, climate, etc., and compiled data from numerous sources around the state into a database that served as the focal point of the data collection efforts during Phase I of the Plan development. During Phase II, the Science and Technical Group worked to evaluate and provide input to the technical assessment, including basin water use analysis and how to estimate and present future water needs.

In addition to these tasks, these various work groups have also assumed additional responsibilities as the Plan was under development. These responsibilities were proposed by the consultant as a means of channeling the collective knowledge and experience of the group members directly into the Plan. These responsibilities are outlined in the figure above, and also listed again in **Table 1-1** below:

Table 1-1. Additional Responsibilities of the Work Groups Focused on Plan Input and Adoption

Work Group	Specific Responsibilities
Policy Subcommittee	Provide lead review of policy white papers
	Help pre-screen options for consensus (continuation of existing work)
	Draft policy language for options/challenges with broad consensus
Science and Technical Subcommittee	Peer review of technical work products such as water inventory, climate change methodology, basin stress maps, etc.
	Help confirm or fill data gaps
	Identify opportunities to "zoom in" to test policy recommendations in areas that may be more localized than the regional basins, but broadly representative and educational
	Help develop a practical approach for estimating realistic future water use potential somewhere between future use projections and total permitted and registered water use (generally seen as overstating actual potential).
WPC Advisory Group	Help develop guidelines to implement the Plan's broad statewide guidance at the local level where appropriate (Drought Response or Climate Adaptation, as possible examples)
	Consider a process for rapid approval of the Draft Plan prior to delivery to the Legislature
WPC Steering Committee	Consider the future management structure (WPC and State Entities) and how they can best be adapted during the implementation phases of the Plan

1.4.2 Addressing the 17 Requirements in the State Statute

On July 1, 2014, Public Act 14-163, "An Act Concerning the Responsibilities of the Water Planning Council," became effective in the State of Connecticut. The Act directs the WPC to develop a State Water Plan in accordance with 17 specific goals and considerations, as listed in **Table 1-2.**

Table 1-2. How the Plan Addresses the 17 Requirements

	Statute Requirement	Background Info	Technical Info	Policy Rec.	Pathway Forward	Outreach	Implementation
1	Identify the quantities and qualities of water that are available for public water supply, health, economic, recreation and environmental benefits on a regional basin scale considering both surface water and groundwater	Appendix E	Sections 2 and 3	Section 5.2.3.2	Section 5.3.2.10	Section 4.6	
2	Identify present and projected demands for water resources on a statewide and regional basin scale		Sections 2.1 3.1			Section 4.6	
3	Recommend the utilization of the state's water resources, including surface and subsurface water, in a manner that balances public water supply, economic development, recreation and ecological health		Section 2	Sections 5.2.3.3 5.2.3.7 5.2.3.11	Sections 5.3.2.1 5.3.2.5 5.3.2.10 5.3.2.11	Section 4.6	Section 6.3
4	Recommend steps to increase the climate resiliency of existing water resources and infrastructure		Sections 2.1.6 3.1.4		Section 5.3.2.12	Section 4.6	Section 6.8
5	Make recommendations for technology and infrastructure upgrades, interconnections and such major engineering works or special districts which may be necessary, including the need, timing and general cost thereof	Appendix D		Section 5.2.3.10	Sections 5.3.2.2 5.3.2.4 5.3.2.13	Section 4.6	Section 6.8
6	Recommend land use and other measures, including an assessment of land acquisition or land protection needs, where appropriate to ensure the desired quality and abundance of water and to promote development in concert with available water resources			Sections 5.2.3.1 5.2.3.2		Section 4.6	Section 6.7
7	Take into account desired ecological, recreational, agricultural, industrial and commercial use of water bodies		Section 2.1	Section 5.2.3.6	Section 5.3.2.11	Section 4.6	Section 6.3 6.7 6.8

	Statute Requirement	Background Info	Technical Info	Policy Rec.	Pathway Forward	Outreach	Implementation
8	Inform residents of the state about the importance of water resource stewardship and conservation	Appendix A		Sections 5.2.3.3 5.2.3.9		Section 4.6 6.1	Section 6.2
9	Establish conservation guidelines and incentives for consumer water conservation with due consideration for energy efficiency			Section 5.2.3.3	Sections 5.3.2.1 5.3.2.12	Sections 5.2.3.9 6.1	
10	Develop a water reuse policy with incentives for matching the quality of the water to the use			Sections 5.2.3.11	Section 5.3.2.9	Section 4.6	
11	Meet data collection and analysis needs to provide for data driven water planning and permitting decisions	Appendix C	Section 2.1	Section 5.2.3.12		Section 4.6	Sections 6.5 6.8.1
12	Take into account the ecological, environmental, public health and safety and economic impact that implementation of the state water plan will have on the state		Section 3.1	Sections 5.2.3.2 5.2.3.5 5.2.3.8	Section 5.3.2.5 5.3.2.6	Section 4.6	Section 6.5 6.8
13	Include short and long-range objectives and strategies to communicate and implement the plan	Appendix A		Section 5.2.3.3 5.2.3.5		Section 4.6 6.1 6.2	Section 6.8
14	Seek to incorporate regional and local plans and programs for water use and management and plans for water and sewerage facilities in the state water plan	Appendix D	Section 2	Sections 5.2.3.4 5.2.3.10 5.2.3.13	Section 5.3.2.2	Section 5.2.3.10	Section 6.6
15	Promote intra-regional solutions and sharing of water resources	Appendix D		Section 5.2.3.10	Section 5.3.2.2	Section 4.6	Section 6.7
16	Develop and recommend strategies to address climate resiliency including the impact of extreme weather events	Appendix F	Section 3.1.3 3.1.4		Section 5.3.2.8 5.3.2.12	Section 4.6	Section 6.8
17	Identify modifications to laws and regulations that are necessary in order to implement the recommendations of the state water plan			Section 5.2	Section 5.3		Section 6.8

Note: *Table 6-2 Tracking Progress towards the Statutory Requirements* is a related component to this table's information, continuing through implementation of the Plan.

The scope of the Plan includes current assessments of water policy, water availability, quality, and use patterns, future projections of water needs and availability due to changes in climate, demand, and regulations, and evaluation of numerous management options to help satisfy the state's out-of-stream and instream water needs for the next 25 years. It was largely informed by the WPC's research into processes used by other states to develop statewide water plans (through the work of a special work group established specifically for this purpose), and by the 17 goals and considerations listed in the statute.

Table 1-2 demonstrates examples of how the Plan has addressed each of the 17 requirements in the statute. From the outset of the one-year planning process, the participants acknowledged that not all issues would be resolved, but that the Plan would advance as many of them as possible toward consensus or clearer understanding. Furthermore, some decisions suggested by the statute are more appropriately left to the Connecticut Legislature, but the Plan provides information, guiding principles, and a framework with which to inform such decisions.

1.4.3 Workshops and Public Involvement

The Plan is being developed with specific and ongoing opportunities for public outreach and involvement. Unlike stakeholder involvement, in which stakeholders generally represent the views and missions of the agencies and organizations they represent, public involvement can include private citizens, individual municipalities, and their respective concerns. The Plan has worked collaboratively with the WPC Steering Committee and the WPC Advisory Group to build off existing communication platforms pertaining to the Plan so that public citizens can find updates and information pertaining to the Plan and the planning process. There were six workshops and six public meetings held during Phase I and Phase II of Plan development, with themes of the workshops shown in the **Figure 1-2** below.



Figure 1-2. Planned Workshops to Support Plan Development

Stakeholders are represented during the workshops through the members of the WPC Steering Committee, which includes the chairs of the Science and Technical Subcommittee, the Policy Subcommittee, and the WPC Advisory Group. Through extension, and by the agreement of the

subcommittee chairs to represent not only their own organizational interests but also those of their committee's constituency, the process includes room for all voices. Subcommittee and Advisory Group members may also consult directly with their chairs during the workshops to augment certain points of view or ask specific questions. In this way, the process focuses discussion efficiently through its representational process, and allows fuller inclusion of specific voices through "caucusing." Other state planning processes have shown that this can be effective – workshops with many dozens or hundreds of participants rarely achieve goals or make meaningful progress.

As summarized in the figure, Workshop 1 held in Phase I included consensus building on the Plan framework, and collaboration on the goals and water management options to be included in the Plan. The three public meetings held in Phase I were introductions to the Plan and summarized completed, ongoing and future activities as part of the Plan development schedule.

Phase II workshops incorporated consensus building on items to be included in the Plan. The Phase II public meetings were held corresponding to specific workshops, so that the results of those workshops could be summarized and shared with the public.

In addition to the specific workshops and public meetings held in Phase I and Phase II, the WPC and its supporting committees and work groups typically hold monthly meetings, which are also open to the public.

As part of information sharing, a project factsheet has been developed for public distribution, which has been made available at the workshops and public meetings. The factsheet is attached to this report as **Appendix A**.

1.4.4 Supporting Information for Informed Decisions

As part of the Plan Goals and Mission Statement (Section 1.3) along with the 17 issues required by the statute (Section 1.4.2), the success of the Plan is dependent on using science and data to recommend action. As included in various sections of this plan, information is gathered and analyzed to build a platform for decision making. This plan includes a policy assessment and a technical condition assessment, which was completed as part of Phase I, and those assessments comprise the supporting information used in Phase II to develop policy guidelines and analytical support for alternatives assessment.

Current and future policy assessment efforts are the white papers developed in Phase I, which are summarized in Sections 2 and 3, along with the full text of the four white papers now included in those sections. The four white papers are titled as follows and as the following sections:

- 2.2.1 Water Management Structure
- 2.2.2 Land Conservation and Economic Development
- 3.2.1 Future Water Management Options
- 3.2.2 Future Water Management Challenges

The current technical condition assessment efforts include data collection, inventory, and demand assessment, included in this plan as the following sections:

- 2.1.1 River Basins in Connecticut
- 2.1.2 Data Collection and Assessment, including the data quality plan, a summary of data collected and an analysis of identified data gaps
- 2.1.3 Current Water Demands
- 2.1.4 Water Inventory by Basin: Availability and Needs
- 2.1.5 Current Water Quality Throughout Connecticut
- 2.1.6 Current Infrastructure Capacity and Planned Improvements

Future technical assessment efforts include future conditions and impacts assessment, which are included in this plan as the following sections:

- 3.1.1 Future Water Demands including out-of-stream and in-stream demands
- 3.1.2 Future Water Supply and Demand Comparison
- 3.1.3 Potential Impacts of Water Conservation
- 3.1.4 Potential Impacts of Climate Change
- 3.1.5 Additional Indicators of Potential Basin Risks, such as land use and seasonal water use patterns
- 3.1.6 Simulating Management Approaches to Guide Decisions, a demonstration of how a model may show water use and change impacts

This science and data collection and analysis effort, both for technical and policy components, and considering both current and future conditions, builds that necessary platform to enable sound decision making for paths forward.

1.4.5 Guiding Principles from Other States' Water Plans

The WPC formed a task committee to examine how other states in the U.S. have approached statewide water planning. This section is taken from their report to the WPC. The entire report is included as Appendix B of this report.

Box 1: Water Planning Principles:

1. Ensure on-going, dedicated funding
2. Be science based with objective, supportable data and modeling
3. Include a public and stakeholder engagement process
4. Employ an integrated approach
5. Ensure an equitable and fair process for balancing values
6. Maintain an on-going, iterative planning process
7. Have planning drive policy and legislative changes
8. Encourage conservation
9. Include a comprehensive education program

The Other States' Plans Workgroup was charged by the WPC to review water plans developed by other states to glean any information applicable to the development of the Connecticut Plan. Using Public Act 14-163, "An Act Concerning the Responsibilities of the Water Planning Council" as the context, the Other States' Plans Workgroup reviewed the state plans developed by nineteen other states. Detailed summaries of the other state plans were compiled and elements that would be helpful in Connecticut's process were highlighted. These elements are divided into two

categories: planning principles and key elements. The difference between the two categories is that "principles" are generally more philosophical in nature and "elements" are related more to the implementation (or mechanics) of the plan.

Nine overarching water planning principles emerged from this review (see Box 1); the most effective state plans consistently held to these principles. The Other States' Plans Workgroup believes that for Connecticut's Plan to be implementable and effective, the state must commit to these principles in the planning process.

Several dozen key elements of a state water plan and the planning process also were identified using both requirements in PA 14-164 and information in other states' plans (see Box 2). These are grouped by (1) state-level institutional and process elements; (2) regional and local elements; and (3) water resource assessment elements.

Box 2: Key Elements of a State Water Plan include:

1. State-level institutional and process elements
2. Regional water planning process elements
3. Water resource assessment elements

Several of the elements related to policy issues identified in previous Connecticut water planning discussions. How other states have grappled with these issues and how they addressed them informed Connecticut's process.

The work of the Other States' Plans Workgroup was not intended to be comprehensive, rather it was an attempt to glean the best information available in a short amount of time to inform Connecticut's water planning process. The workgroup membership was very diverse, encompassing a full range of water stakeholders.

As can be seen throughout the rest of this report, the process in Connecticut has embraced a great deal of the examples set by other states, while including special consideration for issues that are unique to Connecticut.

Section 2

Current Condition Assessment

The Current Condition Assessment attempts to answer the question "Does Connecticut have enough water?" The answer changes based on three factors: (1) the types of conditions being evaluated, (2) the types of water needs being considered, and (3) the potential exercising of unused registered diversions. Generally, while there should be sufficient drinking water in the state between now and 2040, especially considering storage and potential future conservation measures, there may be conditions that make it difficult for a basin to satisfy all out-of-stream and instream needs at the same time in all locations. Out-of-stream use, also called "consumptive" use, supports public supply, industrial, commercial, and agriculture needs. Instream use, also called "non-consumptive" use, supports aquatic life, fishing, recreation and waste assimilation.

On an average daily basis, the 44 regional water basins in Connecticut appear to be well supplied with water to meet the needs of current out-of-stream uses. When instream uses are considered, gaps become apparent, especially in the summer months. While water may be plentiful basin-wide, but it is possible that the right quality and quantity of water may not be available at the locations where it is needed all the time. Detailed evaluations of specific utilities or water systems are necessary to identify where and when these water shortages might occur.

Included at the end of this section are two white papers that describe current water management practices. These papers are not intended to convey positions, priorities, values, or recommendations. Rather, they are factual documents reviewed by the four state agencies with purview over water (DEEP, DPH, OPM, and PURA), as well as the Water Planning Council and its supporting sub-committees and advisory groups.

The first paper (Section 2.2.1) "Current Water Resource Management Structure", focuses on three themes: 1) The roles and responsibilities of the four state entities who collectively manage and regulate water in Connecticut, as well as areas of overlap in their responsibilities, 2) The structure of the Water Planning Council and its supporting committees and work groups, all of whom are tasked with orchestrating the development of the State Water Plan, and 3) Current water management programs in the state and the organizations responsible for their oversight. Included in this paper are overviews of numerous programs and regulatory responsibilities including but not limited to water supply, water quality standards, wastewater, drought management, comprehensive state energy strategy and funding and financing.

The second white paper (Section 2.2.2) "Current (Land) Conservation Patterns, Trends, and Plans and Economic Development Trends", outlines land management practices and how they relate to water policies, watershed protection, aquifer protection, etc. While land management is often governed locally, this paper focuses on general examination of land management trends at regional and statewide scales. It also discusses trends in land development in the eastern, central, and western regions of the state. Ultimately, water and land management policies are intrinsically linked in Connecticut: some water management policies and programs affect land management, and some land management policies and programs affect water management.

2.1 Current Technical Assessment

2.1.1 River Basins in Connecticut

A drainage basin (or watershed) is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. In Connecticut, drainage basins have previously been delineated and categorized at various scales, beginning with 8 major river basins all the way down to 7,067 small drainage basin areas. In between these extremes, 44 regional basins, 337 subregional basins, and 2,898 local basins have been delineated. Connecticut's 8 major basins and 44 regional basins are shown in **Figure 2-1**. The Housatonic, Connecticut and Thames River Basins cover nearly 77% of the state, and extend into the neighboring states. Along the coast, the Southwest, South Central and Southeast basins cover 17% of the state. To the west, the Hudson Basin occurs primarily in New York, and to the east, the Pawcatuck Basin occurs primarily in Rhode Island; however, both have portions in Connecticut. Together, they cover the remaining 6% of the state.

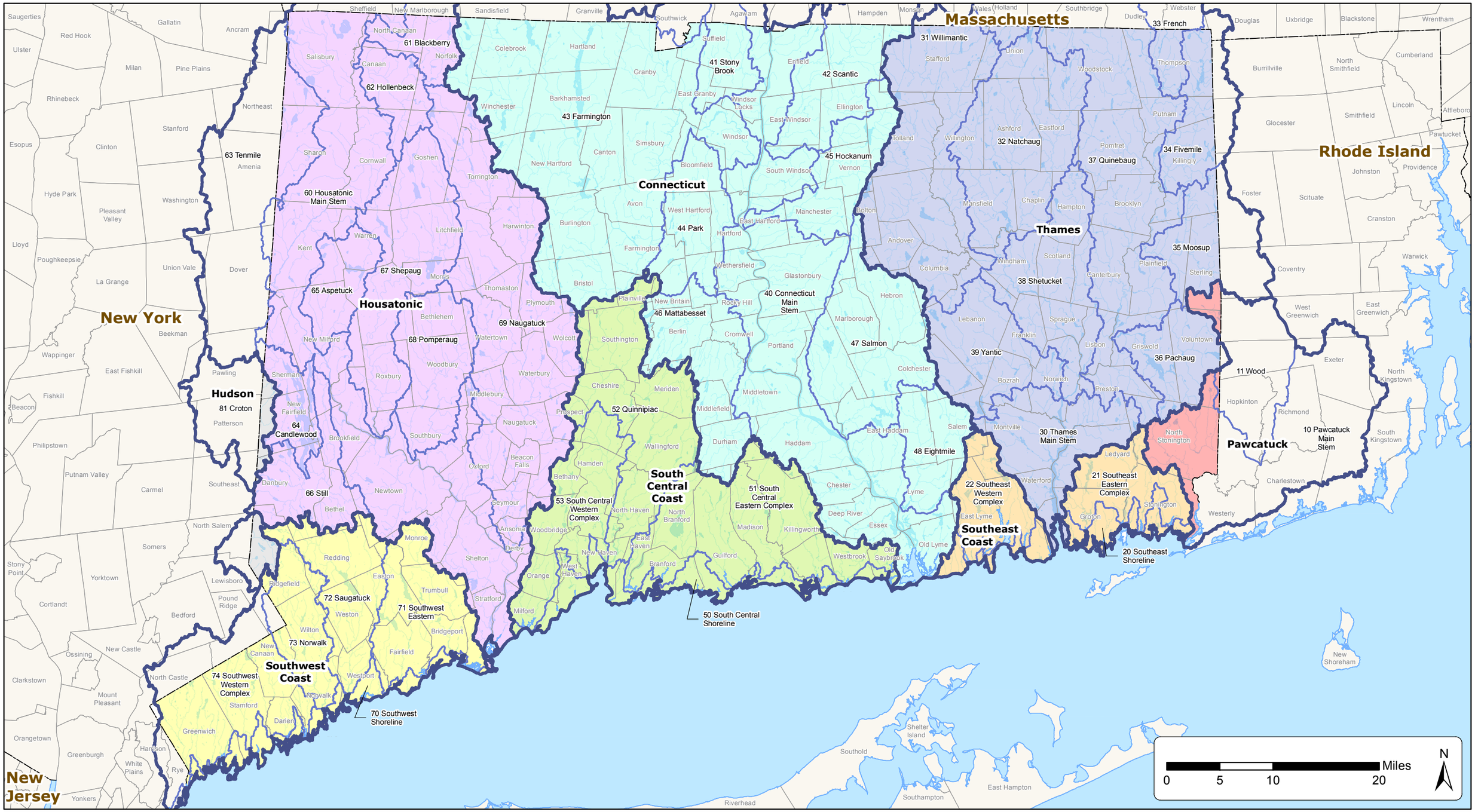
The hierarchical system of drainage basins provides a means to assess water availability at various scales. Demands in the form of surface water withdrawals from streams or reservoirs and groundwater withdrawals from wells can be totaled (with available information, which is not always complete) for a particular drainage basin, and compared to water availability to determine if there are any current or potential future gaps. Much of the focus of the Plan is at the regional basin scale; however, at some locations, it will be necessary to evaluate potential water stress at a more local, sub-regional scale. Regional basins range in size from 31 to 933 square miles and average 150 square miles. **Figure 2-2** provides a conceptual visualization of the flows and uses of water within a river basin and how the surface water and groundwater can interact, collectively referred to as "the Water Cycle."

2.1.2 Data Collection and Assessment

Abundant and accurate data serve as the backbone of any water resources plan, and is especially important for one that provides a framework for water policy and planning statewide. Data supporting both the current and future condition assessments were collected from multiple sources and aggregated into the regional basins, but most notably from the following agencies:

- **United States Geological Survey (USGS).** Data collected and used included streamflow from gaged sites, estimates of groundwater recharge, estimates of evapotranspiration, streamflow statistics derived via the StreamStats[1] program for ungaged locations, and various water quality studies and reports.
- **CT Department of Energy and Environmental Protection (DEEP)**. Data collected and used included summaries of water withdrawal permits and registrations; estimates of withdrawals as reported by registrants during the period 1997 through 2001; preliminary reservoir release rules; wastewater discharges and locations for the period May 2015 through April 2016; and various water quality studies and reports.

[1] https://water.usgs.gov/osw/streamstats/connecticut.html



Legend

- Major Basin
- Regional Basin
- CT Major Waterbody

Major Basins

- Connecticut
- Housatonic
- Hudson
- Pawcatuck
- South Central Coast
- Southeast Coast
- Southwest Coast
- Thames

Figure 2-1
Connecticut's Regional River Basins
Connecticut State Water Plan

CDM Smith | Milone & MacBroom

June, 2017

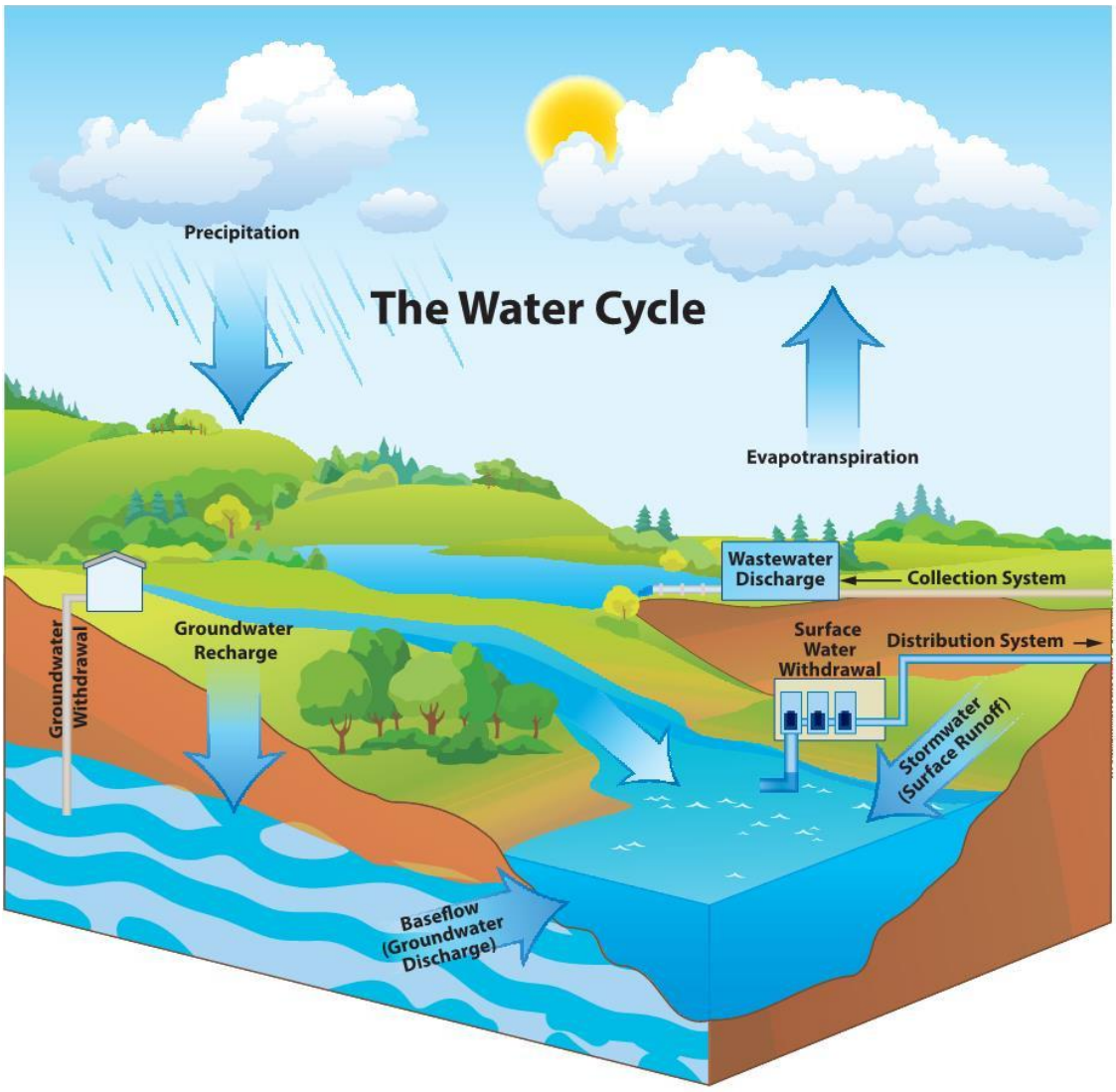


Figure 2-2. The Water Cycle

- **CT Department of Health (DPH)**. Data collected and used included the WUCC Preliminary Water Supply Assessments (including information from Water Supply Plans), safe yield and reported and estimated withdrawals for large community water systems, the High Quality Source List, and the lists of public water systems (community, non-transient non-community, and transient non-community). Demands were then estimated for small community water systems and non-community water systems.
- **U.S. Department of Agriculture (USDA)**. Data collected and used included Census of Agriculture estimates of county-level irrigated acres by crop type.
- **State Data Center**. Population projections were collected from the State Data Center and used to assist with future demand estimation.

It should be recognized that while there are additional sources of potentially useful data, and additional datasets from the source agencies mentioned above, the datasets were too challenging to assimilate into this Plan with significant benefit. For example, hand-written water withdrawal records are available from annual reports submitted to DEEP; however, the quantity and format of this data made it too difficult to compile and use as part of the current conditions assessment.

2.1.2.1 Data Quality Plan

Prior to collecting, compiling and assessing the data used to support the Plan, a Quality Assurance Project Plan (QAPP) was prepared. This is included as **APPENDIX C**. The purpose of the QAPP was to identify the likely sources of data; define criteria for evaluating the quality and usability of the data; and provide requirements for documenting, reducing, validating, and managing the data. All data collected for the Plan was secondary or existing data, which means that it came from existing sources, such as previous studies, state databases or USGS databases.

One especially important component of the QAPP was the Data Quality Decision Tree. All data collected for potential use was evaluated following the step-wise criteria established in the decision tree. In this manner, the data becomes classified for (1) full use, (2) full use with limitations noted, or (3) is not used. Data that was not used did not have a traceable source or was not accompanied by an adequate description. This process ensures that no suspect data is used to support potential water policy decisions.

2.1.2.2 Current Data Gaps

Various gaps and data assimilation challenges were identified during the collection and assessment of data that would support development of the Plan. These gaps and challenges are summarized below.

- **Security of Individual Water Supply Plans and Sanitary Surveys**. Water supply plans and sanitary surveys are exempt from Freedom of Information Act (FOIA) reviews under state security laws, in order to maintain the security and integrity of our water supply areas and facilities. The exemption from disclosure of information in water supply plans and sanitary surveys creates a data gap because the equivalent information must be found elsewhere (when possible) and is not as easily assimilated. Although only about 90 public water systems complete water supply plans, those 90+ systems account for the vast majority of public water supply withdrawals in the state. The problem is somewhat different for sanitary surveys, as they tend to include mainly factual information about systems, and most of the thousands of sanitary surveys are for small systems.
- **Spatial data related to public water systems**. Spatial data (e.g., Geographic Information System [GIS] files) for public water systems is considered secure and cannot be released for use in the Plan. This includes locations of public water supply wells, surface water intakes, system interconnections and detailed mapping of distribution systems. Detailed mapping of distribution systems would be helpful because it could be overlaid with sewer service areas to evaluate the destination of water withdrawn by water utilities. In lieu of detailed spatial data, water withdrawals were aggregated at the regional basin level.
- **True, actual water usage is not known for many of the registered water diversions**. Public Act 02-102 required the holders of registered water diversions to file actual water

use data (estimated or metered) to DEEP in 2002-2003. This was a one-time exercise that did not provide a comprehensive picture of water use by registered diversions. Although there are other methods of determining water use for public water system registrants (e.g., water supply plans and Public Utilities Regulatory Authority (PURA) annual reports for certain systems), registrants that are not public water systems do not commonly report actual water use. This includes many agricultural users, nurseries, golf courses, industries, power generation facilities, extraction and processing (sand and gravel) users, ski facilities, and others. The lack of current water use estimates is considered a significant data gap, given changes in water demand and use over the last 10 to 15 years. This data gap has already been recognized by DEEP. Per PA 04-185, registrants are to report water usage to DEEP upon development of a form by DEEP in consultation with a work group of registrants and agencies, which to date has not been implemented by DEEP.

- **Annual reports of water usage by permitted diversions is neither standardized, nor electronic**. This data gap has already been recognized by DEEP. Per PA 04-185, registered users are to report water usage to DEEP upon development of a form by DEEP in consultation with a work group of registrants and agencies. This form could also be used for permitted diversions. Currently, diversion permit holders are still sending paper copies of annual reports to the Diversion Program, previously the Inland Water Resources Division (IWRD), and these reports are being filed without any data entry effort. There are numerous challenges to overcome before a data entry effort could be useful. The standardization of reporting, well-defined reporting requirements and procedures, and training are recommended activities to overcome this obstacle and eliminate the data gap.
- **The vast majority of small public water systems (community and non-community) are not metering withdrawals, and therefore actual water usage is not known**. These small systems are not required to be registered or permitted because withdrawals are below 50,000 gallons per day (gpd), and they do not file water supply plans or PURA annual reports. Water use estimation can be relatively accurate for some of the small systems (residential) but challenging for others (commercial developments).
- **Some water users recycle water and therefore their water withdrawal figures are not representative of true out-of-stream loss from the environment**. Whether registered or permitted, many of the water users recycle water out of necessity or by choice. These include nurseries and extraction/sand and gravel operations. A review of total withdrawal figures does not reveal how much "fresh" water or makeup water is being withdrawn from watercourses or groundwater sources.
- **Many water utilities operate reservoir systems and meter the withdrawals from the terminal reservoir, thus making it difficult to determine water withdrawals from feeder reservoirs**. In these cases, it is possible to estimate withdrawals from each reservoir by reviewing the proportion of the total safe yield provided by each reservoir, but this approach assumes that current operating rules are similar to historic operating rules. There are likely some cases that feeder reservoir withdrawals are lower than perceived, and an equal number of cases that feeder reservoir withdrawals are higher than perceived. Systems that use multiple groundwater sources represent an equivalent problem when individual wells are not metered but the total wellfield is metered. However, it is generally

easier to estimate withdrawals per well (because pump capacities are known) than withdrawals per reservoir. In the context of the condition assessment, this is only a gap when a reservoir system or a system of wells spans multiple regional basins.

- **Instream Flow Studies**. No comprehensive list was found of watercourses in Connecticut that have been subject to instream flow studies which characterize and quantify the impacts of withdrawals on aquatic habitat. Studies have been completed in the Shepaug, Pomperaug, Quinebaug, Willimantic, Fenton, Natchaug, Farmington, Saugatuck, Aspetuck, and possibly other rivers to support permit applications and flow management plans, however, no centralized repository or database exists. Good information can be found in the studies that have been done, however; for example, the instream flow portion of the Wild and Scenic Study on the Farmington River included analysis of aquatic habitat, spawning, recreation and esthetic values.
- **Private water supply well locations**. Well drillers have been filing permits and completion reports since the 1970s. The reports were scanned between 2000 and 2010 and are now available as images, filed by town and year. While knowing the private well locations would be helpful for the condition assessment, the task was not feasible in a reasonable timeframe. Instead, areas served by public water systems, which are already mapped in GIS, were used to identify remaining areas that are served by private wells.
- **Private groundwater and surface water withdrawals for irrigation.** No data is available to identify and quantify private irrigation withdrawals less than 50,000 gpd from private wells or from streams. While these are not expected to be significant on a statewide scale, localized impacts, especially to small streams, may occur seasonally.
- **Water quality**. There is an abundant amount of surface water and groundwater quality data collected by numerous entities (water utilities, USGS, DEEP, local health departments and districts, citizen scientists, watershed organizations, etc.) however, assimilating and assessing the disparate data was not reasonable given the time frame allotted for the Plan. Instead, the assessment of water quality statewide focused on select studies, which provided regional and statewide summaries of water quality. These include the Integrated Water Quality Report (IWQR) and the Preliminary Water Supply Assessments for the Public Water Supply Management Areas. Additionally, much of the surface water quality data presented in the maps in this section represent data from basins in which only a portion of the rivers and streams were assessed.
- **Population Projections**. Two sets of projections are generally used in Connecticut: those developed by the CT State Data Center (SDC) and those developed by CT Department of Transportation (DOT). When DOT projections are compared to those prepared by the SDC, some discrepancies are noted. For instance, the SDC population projections show more modest growth rates (lower rates) compared to the DOT projections, and in many cases, they show population loss. To be clear, both sets of projections have been correct and both sets have been incorrect in some towns when comparing recent projections to recent population estimates. The State Water Plan Policy Subcommittee has stated that the Plan should use the SDC projections. Since the most recent SDC projections were prepared in 2012, the fact that they are going on 5 years old is considered a data gap. The SDC is in the

process of updating the projections; however, they are not expected to be available until summer 2017.

- **Streamflow**. Streamflow data, which was primarily used to characterize water availability at the regional basin level, is generally abundant throughout state. Only six regional basins do not have USGS gages or are not within the drainage of a downstream gage. This is likely attributed to the fact that these are mostly coastal basins, and the usefulness of gages would be limited due to tidal effects on streamflow. This is only a minor data gap, given that other techniques can be used to estimate water in these regional basins; however, it should be noted that recurring funding challenges threaten the ability to operate and maintain existing gages and limit the ability to install new ones that might provide more accurate data for planning purposes. Many stakeholders voiced an opinion that streamflow monitoring is one of the most critical elements in water planning, and recommended that the State continue to work with USGS to support streamflow monitoring as a high priority.
- **Wastewater**: Not much data are readily available on wasteload allocations and current discharge patterns from smaller wastewater systems. Having this information would help better define flows within each basin.

2.1.3 Current Water Demands

Current water demands can be divided into three broad categories: public water system demand, residential private (domestic) well demand, and non-residential, non-public water system demand. Different methods were used to develop estimates for current demands, depending on the category of demand. For each category, the availability of data varies significantly.

There are current environmental demands as well, though these are not consistently documented or applied. To the extent that they can be documented in the future, ecological demands are included in Section 3, where future demands and regulatory requirements are estimated.

Current water demands have been estimated and summarized as part of the water inventory discussed in Section 2.1.4.3. The approach to estimating water demands for different categories of water users is described in the following sections.

2.1.3.1 Public Water System Demand

Public water systems are generally categorized by the number of people they serve. The four categories are:

- Large community water systems, which serve over 1,000 people;
- Small community water systems, which serve under 1,000 people;
- Transient, non-community water systems, which serve 25 or more different people per day for at least 60 days per year; and
- Non-transient, non-community water systems, which serve 25 or more of the same people each day for at least 6 months per year.

Neither transient nor non-transient systems are required to report actual demand, and for the purposes of estimating current demands, are treated the same and grouped together. The following paragraphs summarize how current demands were totaled for public water systems.

Large Community Water Systems

Large community water system demands were made available during the Water Utility Coordinating process. Large system demand is likely the most accurate figure of all water consumption types in the state, as utilities are legally bound to record and report their systems' demand.

Small Community Water Systems

Water demand figures for small community systems were extracted from the most recent sanitary surveys available for each system where available, for the preparation of the Preliminary Water Supply Assessment reports and subsequent listing in those reports. Water usage reporting is inconsistent for small systems, and actual water demands were available for only 150 of 426 systems. The number of people served by each small system is included in the DPH database of public water systems, and was used to calculate per-capita average water demand for each system that reported an overall average water demand.

Different systems serve different land-use types, information that can be gleaned from the system name, or from other research. The 426 small community systems were subdivided into the following categories by use type: school, mobile home or trailer park, hospital, group home, elderly home, condominium, apartment and mixed. The per-capita demand values calculated from reported demands were averaged within each category and applied to each system that did not report usage. An estimated average demand for each system was then calculated by multiplying by the population served.

Non-Community Water Systems

Non-community water systems are not required to meter water withdrawals, therefore current demands were estimated. For each system, the type of use (e.g., restaurant, retail store, office building) was determined, and per-capita demand estimates for each usage was taken from the 2011 *Connecticut Public Health Code On-site Sewage Disposal Regulations, and Technical Standards for Subsurface Sewage Disposal Systems*, prepared by the CT DPH. Per-capita demand was then multiplied by providing the population served to estimate average daily demand. Some per-capita demand values were not based on the DPH figures because either the usage type did not fit any of the options provided in that document, or the document provided constants for estimating demand based on factors other than population served.

Actual production reports for four systems were reviewed. All of these systems rely on wells on a seasonal basis, and the populations served are subject to change over time. Reported demand figures were normalized to the average population served while pumping was occurring, and then to a 365-day pumping year. The resulting figures represent the average daily per-capita demand for an entire year.

When estimating average daily demand, there are two important sources of potential error: the number of people served by the system, and the per-capita production of the system. Errors in population served can result from poor quality reporting by the community water systems or from changes in those populations over time. Per-capita production figures are expectedly over-estimated by the DPH report to ensure wastewater systems function properly under high-stress conditions. Estimates for schools may be high because of an expectation that students will use

restrooms more frequently than what occurs in practice. Estimates for retreat centers and live-in camps are likely high because they are designed for peak season conditions, and do not account for off-season months with little to no water use. Because errors may occur in both the estimates for population served and per-capita production, it is uncertain whether attempting to address just one of those categories would improve the accuracy of the overall estimates of water demand.

2.1.3.2 Private Well Demand

Residential private wells fall under the 50,000 gpd diversion permit threshold and are therefore not required to report water use. Reasonable estimates can be developed using estimates of the number of people who are not served by a public water supply system, and making some assumptions of average demand per capita. Section 2.1.4.2 provides a detailed explanation of the process used to estimate current demand from private wells.

2.1.3.3 Non-Residential Non-Public Water Systems

Out-of-stream, non-public water system demand includes demand for commercial, industrial, agricultural, golf courses, and quarries.

1997-2001 Registered Diversion Reporting

Owners of registered diversions were required to report water demands to DEEP during the years 1997 through 2001. Although many owners of registered diversions provided only estimations of water usage during that time, it is the only source of demand available from those sources. This data was used in developing demand estimates for commercial and industrial water users.

Agriculture

Permit and registration data for agricultural water uses were provided by DEEP. While only three permits – all for watering nursery plants – were identified, 384 registrations were found, although not all are currently active. The permit and registration data was used to assign demands to the appropriate regional basin. Irrigation was estimated by regional basin using total irrigated acres from the USDA Census of Agriculture by county, and the number of DEEP registrations for each regional basin. A crop irrigation requirement of 1.0 acre feet (AF) per acre was assumed for all irrigated acres. Statewide current water demand for agriculture was estimated at 9,300 AF per year or 8.3 million gallons per day (mgd). In the peak demand months of July and August, demand is estimated be 24 to 38 mgd.

Golf Courses

Diversion permit data for golf courses was obtained from DEEP. Since permit holders are not required to record withdrawals which are less than 50,000 gallons per day, only a small number of golf courses reported historical withdrawal data. These demands were totaled and included in the water inventory discussed in the following section.

To understand the significance of this data gap, a method was developed to approximate total demand from golf courses. A list of 184 golf courses in Connecticut was obtained from the Professional Golfers' Association of America (PGA). Locations of the courses were identified and mapped. Monthly reported withdrawal amounts contained in the DEEP permit files for eight golf

courses were totaled, then averaged. These monthly averages were then applied to all remaining golf courses on the list, and adjusted based on size (i.e., number of holes). The estimates, although very approximate and likely to vary significantly year-to-year, suggest that current statewide water demand for golf courses is in the range of 2,500 million gallons per year. In the peak demand months of July and August, demand is estimated to 20 to 27 mgd.

Sand and Gravel Operations (Quarries)

A limited amount of diversion permit data for sand and gravel operations was obtained from DEEP. Many of the sand and gravel operations use water for washing extracted material and recycle it out of necessity or by choice. Other diversion permits are for dewatering, and do not represent an out-of-stream use. As such, there is limited available data that reveals the true amount of water that is withdrawn and not returned from either surface water or groundwater.

2.1.4 Water Inventory by Basin: Availability and Needs

2.1.4.1 Water Inventory Description

A water inventory is used to quantify and understand the movement of water through hydrologic cycle. Water inventories can be completed at a basin, regional basin or subbasin level, although each approach may have unique limitations based on the quantity and quality of data available to provide an assessment of the system. There are many uses for preparing water inventories that support water planning and policy making in Connecticut, the most important of which include:

- Developing an understanding of the availability, movement, and use of water within a basin.
- Developing a concise means of comparing basins with each other in terms of water availability and water consumption.
- Identifying basins that have a relatively high level of water consumption.
- Comparing the natural versus manmade components of the hydrologic cycle.
- Identifying subbasins where large exports or imports of water are occurring.
- Identifying where certain water management decisions will result in the most impact by understanding which basins may have water surpluses and which may have potential shortfalls with respect to satisfying all out-of-stream and instream uses.
- Providing a basis to assess sustainability of water resources.

The water inventory accounts for both the natural movement of water within the hydrologic cycle, as well as movement of water resulting from human activities. Note that the water inventory does not account for the storage of water, whether it be surface water stored in a reservoir or groundwater stored in an aquifer. The significance of storage is addressed outside of the water inventory, which as noted above, focuses on the movement of water. The natural elements of the water inventory include:

- **Precipitation:** the total rain and snowfall that occurs in the watershed.
- **Recharge:** the portion of precipitation that can potentially infiltrate through the unsaturated soils and recharges the groundwater system.

- **Stormflow:** the portion of precipitation that flows over the land surface and into streams.
- **Evapotranspiration:** the portion of water that either evaporates into water vapor and returns to the atmosphere or is taken up by the roots of plants and returned to the atmosphere via water loss through stems and leaves.

The components of the water inventory that are a result of human activities include:

- **Surface and Groundwater Withdrawals:** the portion of water that is withdrawn from a stream, river, lake, reservoir or well and used for drinking water, irrigation, energy production, industrial use, or other human activity. In the water inventory, groundwater withdrawals are typically separated into (1) domestic withdrawals from private wells, typically serving a single residence, and (2) all other wells which are typically used for public supply, agriculture or industry.
- **Surface and Groundwater Discharges:** the portion of water that is typically treated at a wastewater treatment plant and returned to a surface water body or applied to the land or subsurface system, where it recharges the groundwater system. In the water inventory, discharges are typically separated into (1) surface water discharges from industrial and publicly operated wastewater treatment systems, and (2) discharges from domestic on-site wastewater treatment systems (septic systems).

The water inventory can be presented and evaluated in terms of water entering the system via Precipitation (P) and water leaving the system via evapotranspiration (ET), stormflow (SF) and baseflow (BF) to streams. Stormflow and baseflow can be combined to represent total streamflow. In the water inventory, there is an underlying assumption that groundwater and surface water basins generally coincide, thus groundwater can be spatially referenced to the regional basins. While this assumption does not always hold true throughout the state (i.e., some groundwater may move across basin lines), it does provide a reasonable framework for quantifying and assessing groundwater availability and demands at a regional scale. This approach is especially useful since the analysis of streamflow records can be used to provide an estimate of baseflow, which represents potential recharge to the aquifers. It should be recognized that other factors may impact recharge, such as wells located near a stream, which induce infiltration from the stream.

The water inventory can be expanded to include the components that are associated with human activity as follows:

Water Entering the System:
Precipitation (P)
Wastewater and industrial discharge to groundwater (WWIND Rech)
Estimated domestic recharge from onsite wastewater treatment systems (EDR)
Wastewater discharge to rivers (SW Disch)

Water Leaving the System:
Evapotranspiration (ET)
Stormflow (SF)
Baseflow (BF)

Surface water withdrawals (SWW) from rivers lakes and reservoirs
Groundwater withdrawals (GWW) for public supply, industrial, commercial and agricultural use
Estimated domestic withdrawals from private wells (EDW)

It is important to note that water entering the system and water leaving the system will not necessarily be equal for numerous reasons, which may be both real or due to data limitations and the approximate nature of the estimates. Real reasons for differences may include large imports or exports of water between regional basins. In theory, if there are no imports to and exports from the regional basin, and there is no change in water storage, then the they will be equal.

2.1.4.2 Building the Regional Basin Water Inventories

The supporting data and methodology that was used to build the water inventory at the regional basin level are described in the following paragraphs. Although the accuracy of each component is difficult to assess, a range of expected accuracy is provided for each term based on the source and type of data and the methods used to generate the estimates.

Precipitation (P)

Precipitation records from 1985 to 2014 were collected from six long-term stations located in Connecticut and seven stations in New York, Massachusetts and Rhode Island. The variability in annual precipitation averages across the state ranges from 43 inches per year (in/yr) at Bridgeport, to 52.7 in/yr at Stamford. A GIS "spline interpolation" methodology was used to create a statewide, 30-year average annual precipitation contour based on the annual averages from the 13 gages. Calculations were performed using GIS to develop a 30-year average annual precipitation amount for each regional basin based on the contours. The accuracy of these averages is subject to potential station errors/bias, and the fact that many regional basin estimates are based on interpolated values. The long-term regional basin precipitation averages are expected to be accurate to within 10-20%.

Wastewater and Industrial Recharge to Groundwater (WWIND Rech)

Wastewater and industrial recharge occurs at sites where wastewater is land-applied in the form of sand filtration, spray irrigation, drip irrigation, discharged into injection wells, or other means of applying to the land or subsurface. DEEP records of wastewater discharge to groundwater were not made available for this study; however, DEEP indicated that such systems are relatively few in numbers and their minor discharges are insignificant to the water inventory, even at a sub-regional basin level. As a result, this term was removed from the water inventory.

Estimated Domestic Recharge (EDR)

Domestic recharge into onsite wastewater treatment systems is not monitored or reported, so it must be estimated. The first step in estimating domestic recharge for the basin was to determine the number of people that are served by onsite wastewater treatment systems. GIS data layers of sewer service areas (provided by DEEP) were used to determine areas served by sewer systems. 2010 Census block data was brought into GIS, and the total population within these areas were removed from the database. The remaining population was assumed to be served by onsite wastewater treatment systems.

The second step was to determine the estimated domestic recharge (EDR) rate. The amount of wastewater being returned through onsite wastewater treatment systems was estimated using several simplifying assumptions including an average per capita out-of-stream water use (either 61.2, 63.3 or 67.8 gpd, depending on location) and the portion of water that recharges the groundwater system through septic systems. The accuracy of the EDR term is subject to numerous assumptions and estimates and is expected to be within 20-50%.

Surface Water Discharges (SW Disch)

Municipal and industrial surface water discharge locations and amounts were made available by DEEP. Average monthly discharge from May 2015 through April 2016 were provided and totaled to arrive at current annual average amount for each location. These were then brought into GIS and totaled for each regional basin. The discharge estimates are subject to potential metering and reporting errors and are expected to be accurate to within 10-20%. The discharge from centralized wastewater treatment systems represents a future opportunity for reclaimed water, as discussed elsewhere in the Plan.

Evapotranspiration (ET)

Estimates of ET for each regional basin were developed based on estimated mean annual ET contours developed by the USGS for the period 1951-1980 (Randall, 1996[2]). The long term regional basin averages are expected to be accurate to within 15-25%, given that ET is not easily measured.

Stormflow (SF) and Baseflow (BF)

Stormflow (or runoff) and BF were estimated using USGS measured streamflow from 1985 to present. The USGS stream "GAGES-II" dataset (USGS, 2011[3]) was used as it is limited to stream gages with more than 20 complete years of record since 1950, and/or active gages (some of which have less than 20 years of record). The GAGES-II dataset also characterizes the drainage to each gage as "reference" or "non-reference" based on anthropogenic indicators of watershed disturbance. This facilitates its use in developing estimates for SF and BF that generally reflect natural hydrologic conditions.

Selecting the appropriate streamflow gage or gages is the first step in developing stormflow and BF estimates at the regional basin level. A gage or gages within the regional basin are given priority. Several factors are then evaluated to determine if additional or alternative gages may need to be considered as reference gages for the basin. These factors include: the level of upstream impairment such as flow regulation from a reservoir; the relative size of the stream gage(s) drainage area compared to the regional basin area; the period of record of the stream gage; and the representativeness of the regional basin characteristics, such as slope, land cover, and major geologic unit, to the stream gage drainage basin characteristics.

BF is the component of streamflow that can be attributed to groundwater discharge into streams. BF can be estimated several ways. For the water inventory, the USGS-developed Baseflow Index (BFI) was used (Wolock, 2003[4]). The BFI is the ratio of BF to total flow, expressed as a

[2] Randall, Alan D, 1996. Mean Annual Precipitation and Evapotranspiration – Plate 2. USGS Open File Report 96-395.
[3] USGS, Sep 2011, GAGES-II (Geospatial Attributes of Gages for Evaluating Streamflow) summary report.
[4] Wolock, D.M., 2003, Base-flow index grid for the conterminous United States: U.S. Geological Survey Open-File Report 03–

percentage. The USGS created a 1-kilometer (km) raster dataset for the entire conterminous US by interpolating BFI point values estimated at USGS stream gages. The point values were computed using an automated stream hydrograph separation computer program. GIS was used to average BFI values for each regional basin in Connecticut, based on the 1-km BFI raster dataset. Each regional basin's BFI was multiplied by the total streamflow estimate to arrive at estimates for SF and BF (the two additive components of total streamflow). The long term regional basin averages for both SF and BF are expected to be accurate to within 15-25%, or potentially higher for basins which do not have streamflow gages or only have streamflow gages that are influenced by upstream reservoirs, withdrawals or discharges.

Surface Water Withdrawals (SWW)

Surface water withdrawals for public water systems, non-public water systems, agriculture and other uses were estimated from various databases provided by DEEP. Depending on the type of system (e.g., community vs. non-community, large vs. small, public vs. industry, golf, sand and gravel, etc.), withdrawals were estimated differently, as described in Section 2.1.3. For example, some systems have meters and have, at times, reported actual withdrawal amounts. Other systems lacking meters provided estimates.

Surface water withdrawals for agriculture were estimated based on data from the USDA Census of Agriculture and water use registrations reported to DEEP. It is assumed that all agriculture water use for irrigation purposes is lost from the basin through evapotranspiration, and none is returned to the basin. The surface water withdrawals are expected to be accurate to within 10-20%.

Groundwater Withdrawals (GWW)

GWW for public water systems, non-public water systems, agriculture and other uses were estimated from various databases provided by DEEP. The same limitations and assumptions regarding withdrawal and demand estimates for surface water also apply to groundwater. Some small systems had no reported withdrawal data or estimates, and were not included in the water inventory. Because these were typically small systems, the exclusion was deemed to have little to no impact on the water inventory. The accuracy of the GWW may vary widely depending on the withdrawal. Withdrawals from larger systems, which are typically metered, are likely to be accurate to within 5-15%. Small system withdrawals, many of which are estimated, are likely to be accurate to within 15-25%.

Estimated Domestic Withdrawals (EDW)

Domestic withdrawals were estimated using a similar approach to that used to estimate the EDR term. A GIS data layer of public water supply service areas was used to determine the areas within each regional basin that were served by publicly-supplied surface water. The population within these areas was removed from the database. The total population not within the limits of the public water service areas was assumed to be served by domestic wells. The amount of water withdrawn on a per capita basis was approximated based on the same assumptions used for the EDR term. The EDW term is subject to numerous assumptions and estimates and is expected to be accurate to within 20-30%.

263, digital data set

2.1.4.3 Water Inventory Results

The water inventory was developed using estimates of recent, average annual conditions for both the natural components of the water budget and the withdrawals and discharges. (Note that peak/summer withdrawals and streamflow is discussed later in this section.) The water inventories for each regional basin are shown in **Table 2-1**, grouped by major basin. All values are shown in in/yr. The rate in/yr is calculated by dividing the total amount of water for the year (in cubic feet) by the regional basin drainage area (in square feet). In this manner, the size of the basin will not affect the numbers in the columns, and each regional basin can be compared directly with all other basins. The final column in Table 2-1 shows the difference between water coming in and water leaving, and is an approximate indicator of imports to, and exports from each regional basin. Due to the estimated nature of each component of the water inventory, the differences can only be interpreted as rough indicators of imports and exports. Small values (e.g., from -3 to 3 in/yr) may not be true imports or exports; however larger values (less than -3 or greater than 3 in/yr) are likely to indicate that water is entering or leaving.

Current average annual withdrawals for surface water and groundwater combined are shown in **Figure 2-3**. The regional basins with current withdrawals above 4 in/yr include the Southwest Western Complex (7.04 in/yr), Norwalk (5.83 in/yr), Southeast Eastern Complex (4.76 in/yr), Hockanum (4.75 in/yr), Southwest Eastern Complex (4.40 in/yr) and Southcentral Eastern Complex (4.13 in/yr). Over half of the regional basins have withdrawals less than 1 in/yr, and over two-thirds are less than 2 in/yr. Statewide, current total average annual water withdrawals (for out-of-stream use) are estimated to be 444 mgd. Net groundwater withdrawals are 89 mgd, or 20% of the total. Surface water withdrawals are 355 mgd, or 80% of the total. Note that several regional basins are estimated to have negative net withdrawals. This is because more water is estimated to be returned to the aquifer through onsite wastewater systems than is removed from streams or aquifers. Typically, this occurs when water is withdrawn from an adjacent basin and is returned via septic tanks.

Total streamflow in each regional basin serves as a reasonable measure of water availability in the context of the water inventory, ignoring storage provided by reservoirs and aquifers. It is important, however, to recognize that not all water is accessible or available for certain use. For example, in order to sustain healthy rivers and the aquatic resources they support, sufficient water must be left in a stream. Therefore, the water available for withdrawal (other uses) may be limited. Furthermore, only surface water that is classified as A or AA and groundwater that is classified as GA or GAA are available for existing or potential public supply purposes (areas of the state noted as A, AA, GA, or GAA have a primary use for public drinking water and for the most part are protected high quality source waters for human consumption, see Sections WP1-6.1 and WP1-6.2 for applicable regulations and statutes). Also, some water stored in the ground may not be easily extracted and therefore accessibility may be limited. Lastly, water needed near the headwaters of a basin or subbasin may not be available to match localized demand even if the basin as a whole produces sufficient water. Headwater streams are some of the most sensitive stream habitats and are critical to supporting cold water species such as the native brook trout,, and are important to the lifecycle of many aquatic organisms.

Table 2-1. Water Inventory of the Regional Basins

	Water Entering the System (in/yr)			Water Leaving the System (in/yr)								
							Surface Water Withdrawals (SWW)		Groundwater Withdrawals (GWW)			
Regional Basin No. and Name	Precipitation (P)	Surface Water Discharge (SW Disch)	Estimated Domestic Recharge (EDR)	Evapo-transpiration (ET)	Stormflow (SF)	Baseflow (BF)	*for Agriculture*	*for Public Water Supply, Industrial and Other Uses*	*for Agriculture*	*for Public Water Supply, Industrial and Other Uses*	*from private wells (EDW)*	Difference (Entering - Leaving)
Regional Basins in the Pawcatuck Major Basin												
10 Pawcatuck Main Stem	52.00	0.21	0.12	22.71	9.30	18.05	0.00	0.00	0.00	0.03	0.10	2.15
11 Wood	50.94	0.00	0.04	22.62	10.22	18.37	0.00	0.00	0.00	0.00	0.06	-0.28
Regional Basins in the Southeast Coast Major Basin												
20 Southeast Shoreline	49.09	1.65	0.33	22.90	12.51	17.15	0.00	0.02	0.00	0.07	0.09	-1.68
21 Southeast Eastern Complex	50.12	0.04	0.28	22.83	11.50	18.16	0.02	2.44	0.00	1.78	0.15	-6.43
22 Southeast Western Complex	47.99	0.00	0.19	22.87	14.46	15.21	0.00	2.15	0.00	0.83	0.11	-7.44
Regional Basins in the Thames Major Basin												
30 Thames Main Stem	49.03	7.71	0.30	22.80	11.60	13.79	0.01	0.47	0.00	0.22	0.17	7.98
31 Willimantic	48.72	0.32	0.25	22.52	12.36	13.16	0.00	0.05	0.00	0.18	0.29	0.74
32 Natchaug	49.19	0.00	0.12	22.44	13.86	13.40	0.00	0.25	0.00	0.05	0.13	-0.83
33 French	45.33	0.00	0.17	21.96	13.02	14.25	0.00	0.00	0.00	0.22	0.19	-4.13
34 Fivemile	46.82	0.00	0.17	22.26	13.20	13.90	0.00	0.00	0.00	0.25	0.17	-2.80
35 Moosup*	48.97	0.30	0.17	22.48	11.99	15.17	0.00	0.54	0.00	2.42	0.21	-3.38
36 Pachaug	50.32	0.00	0.12	22.65	10.89	16.16	0.02	0.00	0.00	0.03	0.13	0.56
37 Quinebaug	48.44	0.43	0.15	22.30	13.08	12.86	0.02	0.11	0.00	0.41	0.15	0.08
38 Shetucket	49.43	0.02	0.17	22.63	12.19	12.55	0.04	0.18	0.00	0.04	0.16	1.82
39 Yantic	48.80	0.73	0.16	22.74	12.39	12.90	0.10	0.87	0.00	0.02	0.15	0.52
Regional Basins in the Connecticut Major Basin												
40 Connecticut Main Stem	47.02	16.56	0.31	22.68	12.90	12.89	0.07	3.40	0.01	0.48	0.16	11.29
41 Stony Brook	47.02	0.00	0.24	22.30	14.39	14.14	0.29	0.04	0.04	0.06	0.17	-4.17
42 Scantic	47.87	0.01	0.32	22.39	11.25	12.97	0.21	0.09	0.04	1.70	0.16	-0.61
43 Farmington*	46.69	0.79	0.25	21.55	14.70	13.96	0.05	2.98	0.02	0.54	0.15	-6.23
44 Park	46.43	3.78	0.40	22.47	15.80	13.88	0.02	0.13	0.01	0.03	0.03	-1.74
45 Hockanum	47.93	4.57	0.45	22.58	12.05	13.24	0.01	4.03	0.01	0.98	0.17	-0.11
46 Mattabesset	45.32	3.01	0.41	22.74	14.14	13.85	0.03	1.54	0.01	0.41	0.19	-4.17
47 Salmon	47.79	0.00	0.25	22.76	12.09	13.19	0.00	0.01	0.00	0.12	0.31	-0.44
48 Eightmile	47.83	0.00	0.08	22.83	14.94	14.66	0.00	0.00	0.00	0.01	0.11	-4.65

Please refer to Section 2.1.4.2 "Building the Regional Basin Water Inventories" for a summary of the sources and methods used to develop the values presented above.
** Appreciable stormflow also enters these three regional basins from out-of-state, but is not included in the inventory shown above.*

Table 2-1. Water Inventory of the Regional Basins (continued)

	Water Entering the System (in/yr)			Water Leaving the System (in/yr)								
							Surface Water Withdrawals		Groundwater Withdrawals			
Regional Basin Name	Precipitation (P)	Surface Water Discharge (SW Disch)	Estimated Domestic Recharge (EDR)	Evapo-transpiration (ET)	Stormflow (SF)	Baseflow (BF)	*for Agriculture*	*for Public Water Supply, Industrial and Other Uses*	*for Agriculture*	*for Public Water Supply, Industrial and Other Uses*	*from private wells (EDW)*	Difference (Entering - Leaving)
Regional Basins in the South Central Coast Major Basin												
50 South Central Shoreline	42.64	11.70	0.62	23.34	11.89	10.70	0.02	0.02	0.00	0.00	0.07	8.90
51 South Central Eastern Complex	44.56	0.00	0.40	23.09	11.74	10.85	0.06	3.72	0.01	0.42	0.31	-5.24
52 Quinnipiac	43.71	3.18	0.50	22.76	12.43	12.19	0.06	1.12	0.02	1.94	0.11	-3.24
53 South Central Western Complex	42.16	0.00	0.51	23.12	13.75	12.82	0.02	2.62	0.00	1.02	0.14	-10.81
Regional Basins in the Housatonic Major Basin												
60 Housatonic Main Stem	45.66	1.17	0.27	20.92	14.75	13.09	0.02	0.28	0.01	0.59	0.18	-2.73
61 Blackberry	46.83	0.61	0.06	20.71	14.89	13.57	0.00	0.00	0.00	0.20	0.06	-1.94
62 Hollenbeck	46.68	0.00	0.02	20.83	14.74	13.92	0.00	0.06	0.00	0.01	0.03	-2.89
63 Tenmile	46.18	0.02	0.06	20.98	10.63	11.34	0.00	0.06	0.00	0.00	0.06	3.19
64 Candlewood	50.29	0.01	0.43	21.74	12.95	13.62	0.00	0.00	0.00	0.24	0.31	1.88
65 Aspetuck	47.94	0.00	0.16	21.34	11.06	10.91	0.00	0.00	0.00	0.03	0.17	4.59
66 Still	50.97	2.47	0.79	22.18	13.50	13.31	0.00	2.32	0.00	0.48	0.30	2.13
67 Shepaug	47.42	0.05	0.09	21.45	14.32	13.00	0.00	1.12	0.00	0.06	0.11	-2.50
68 Pomperaug	47.06	0.11	0.25	21.90	14.54	12.77	0.01	0.00	0.00	0.36	0.25	-2.43
69 Naugatuck	45.37	2.14	0.35	22.06	14.42	13.21	0.01	1.45	0.00	0.20	0.21	-3.70
Regional Basins in the Southwest Coast Major Basin												
70 Southwest Shoreline	49.60	31.85	0.48	23.67	12.29	12.62	0.00	0.00	0.00	0.00	0.00	33.35
71 Southwest Eastern	46.49	0.07	0.48	23.35	13.08	11.82	0.00	4.82	0.00	0.00	0.06	-6.11
72 Saugatuck	50.18	0.00	0.42	23.03	13.75	12.66	0.00	1.70	0.01	0.83	0.35	-1.73
73 Norwalk	51.70	4.86	0.57	23.16	13.45	12.57	0.00	3.83	0.00	2.14	0.42	1.56
74 Southwest Western Complex*	52.45	0.20	0.53	23.34	14.33	12.71	0.00	7.04	0.00	0.12	0.24	-4.61
Regional Basins in the Hudson Major Basin												
81 Croton	51.20	0.00	0.52	21.89	13.29	13.87	0.00	0.00	0.00	1.61	0.43	0.63

Please refer to Section 2.1.4.2 "Building the Regional Basin Water Inventories" for a summary of the sources and methods used to develop the values presented above.
** Appreciable stormflow also enters these three regional basins from out-of-state, but is not included in the inventory shown above.*

Massachusetts

Rhode Island

New York

New Jersey

Connecticut

Housatonic

Thames

Pawcatuck

Hudson

Southwest Coast

South Central Coast

Southeast Coast

43 Farmington 3.50 in/yr

61 Blackberry 0.20 in/yr

41 Stony Brook 0.36 in/yr

42 Scantic 1.88 in/yr

33 French 0.24 in/yr

62 Hollenbeck 0.08 in/yr

63 Tenmile 0.06 in/yr

45 Hockanum 4.75 in/yr

32 Natchaug 0.31 in/yr

34 Fivemile 0.26 in/yr

37 Quinebaug 0.55 in/yr

60 Housatonic Main Stem 0.80 in/yr

31 Willimantic 0.26 in/yr

67 Shepaug 1.20 in/yr

44 Park -0.20 in/yr

35 Moosup 0.54 in/yr

40 Connecticut Main Stem 3.82 in/yr

65 Aspetuck 0.03 in/yr

38 Shetucket 0.26 in/yr

69 Naugatuck 1.52 in/yr

46 Mattabesset 1.77 in/yr

47 Salmon 0.19 in/yr

68 Pomperaug 0.37 in/yr

39 Yantic 0.99 in/yr

36 Pachaug 0.05 in/yr

11 Wood 0.02 in/yr

10 Pawcatuck Main Stem 0.01 in/yr

52 Quinnipiac 2.76 in/yr

81 Croton 1.52 in/yr

48 Eightmile 0.04 in/yr

30 Thames Main Stem 0.57 in/yr

64 Candlewood 0.12 in/yr

21 Southeast Eastern Complex 4.76 in/yr

66 Still 2.31 in/yr

51 South Central Eastern Complex 4.13 in/yr

22 Southeast Western Complex 3.74 in/yr

53 South Central Western Complex 3.05 in/yr

72 Saugatuck 2.47 in/yr

20 Southeast Shoreline -0.14 in/yr

71 Southwest Eastern 4.40 in/yr

50 South Central Shoreline -0.50 in/yr

73 Norwalk 5.83 in/yr

74 Southwest Western Complex 7.04 in/yr

70 Southwest Shoreline -0.47 in/yr

This figure can be used to screen basins for future management activity; detailed local activity and impact will need additional review and analysis.

0 5 10 20 Miles

N

Legend

- Major Basin
- Regional Basin

Current average annual water withdrawals (in/yr)

< 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7

Figure 2-3
Average Annual Water Withdrawals
Connecticut State Water Plan

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May, 2017

Current average annual streamflow is shown in **Figure 2-4**. Streamflow originating within each regional basin ranges from just below 22 in/yr in the Aspetuck and Tenmile regional basins, to around 30 in/yr in the regional basins of the Southeast Coast. Three regional basins, Moosup, Farmington, and Southwest Western Complex receive an appreciable amount of streamflow from Rhode Island, Massachusetts, or New York, respectively. Their out-of-state flows are included in the streamflow totals shown on Figure 2-4 and are accounted for in subsequent figures in Sections 2 and 3.

Water is needed for both out-of-stream and instream use. Out-of-stream use, also called "consumptive" use, supports public supply, industrial, commercial, and agriculture needs. Instream use, also called "non-consumptive" use, supports aquatic life, fishing, recreation and waste assimilation. The amount of instream flow necessary to support and protect aquatic life has been the subject of much study and debate in Connecticut and in other states. Generally, ecologically protective flows are considered to be flows that support desirable aquatic life at densities similar to those expected under natural conditions. Although natural flows may not always be optimal flows and natural variability in flow over time and at specific times may adversely impact aquatic life even in the absence of human influence, natural variability is a crucial factor for certain life-sustaining functions. Examples include floodplain flooding which provides access to the floodplain for juvenile species and seed dispersal, and high spring flows which cue upstream spawning migrations. To account for instream water needs in the context of the State Water Plan, several different metrics are used, as calculated for each regional basin using the Connecticut StreamStats program:

- To represent instream (ecological flow) needs on annual basis, the median annual natural flow, also called the annual Q50, is used.
- To represent instream (ecological flow) needs for summer months, when there has been an antecedent wet period, the median annual flow (Q50) for July through October is used. This is also called the Rearing and Growth - Wet bioperiod.
- To represent instream (ecological flow) needs for summer months, when there has been an antecedent dry period, the streamflow that is exceeded 80 percent of the time (Q80) during July through October is used. This is also called the Rearing and Growth – Dry bioperiod.

These flow levels correspond to the statistical flows required as downstream releases from certain reservoirs in the state, as specified in the newly released Stream Flow Standards. The difference is that instead of being applied to a specific reservoir and its drainage area, the statistics are estimated here for each entire regional basin.

Water needs can be compared to total streamflow as an indicator of water stress and to identify basins where potential gaps are most likely to occur. Out-of-stream needs and current required streamflow releases[5] from reservoirs, as a percent of average annual streamflow for each regional basin, are shown in **Figure 2-5.** The highest percent of out-of-stream water needs and required reservoir releases compared to streamflow occurs in the Norwalk (22%), Hockanum (19%) and South Central Eastern Complex (18%). Total water needed for out-of-stream uses and required reservoir releases is greater than 10% of average annual streamflow in 10 of the 44 regional basins.

[5] Currently, there are just over 20 streamflow releases from reservoirs that are required by the Minimum Streamflow Regulations or other legal agreements. The release amounts are generally between 0.5 and 2 cfs, but some are as low as 0.1 cfs and as high as 22 cfs.

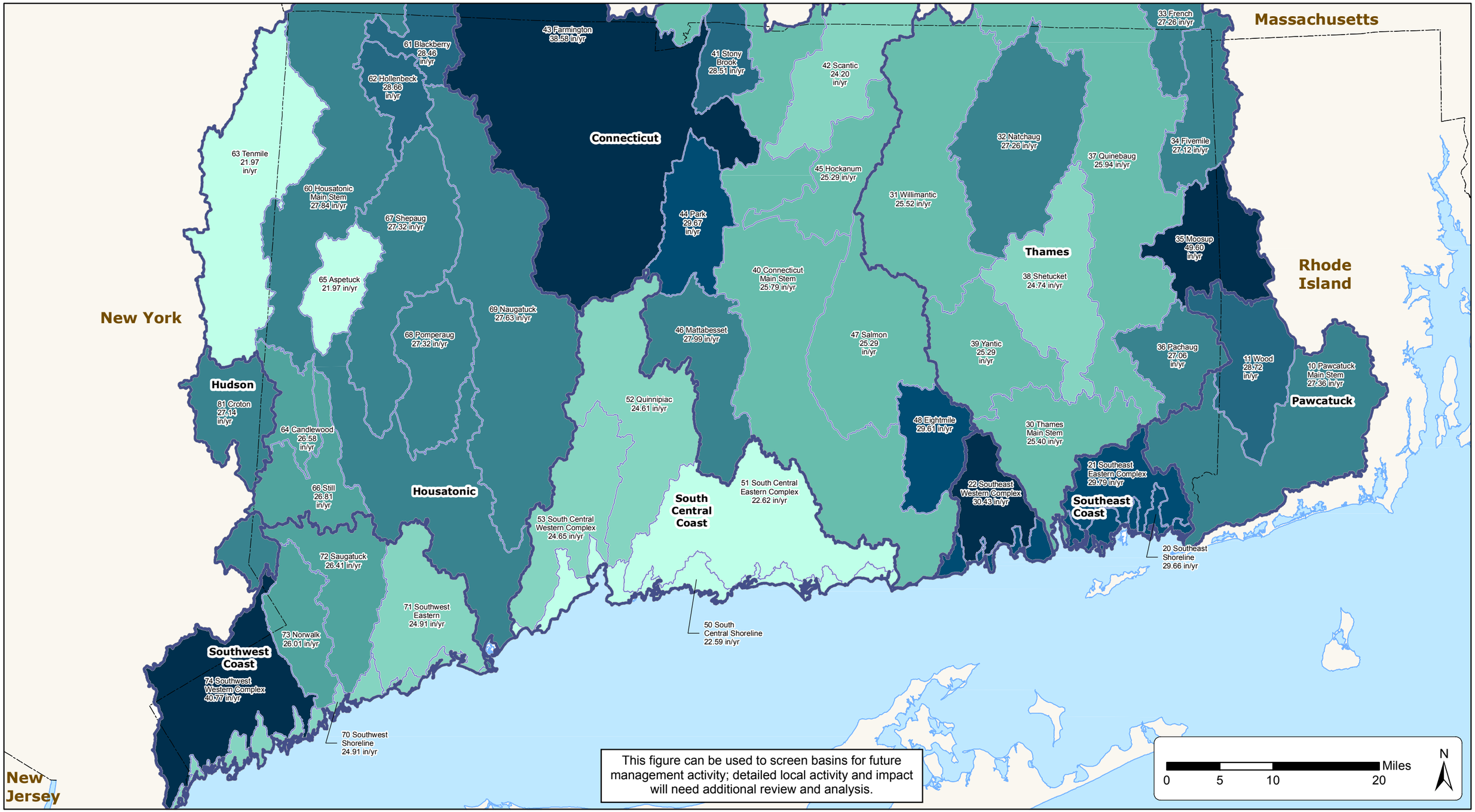
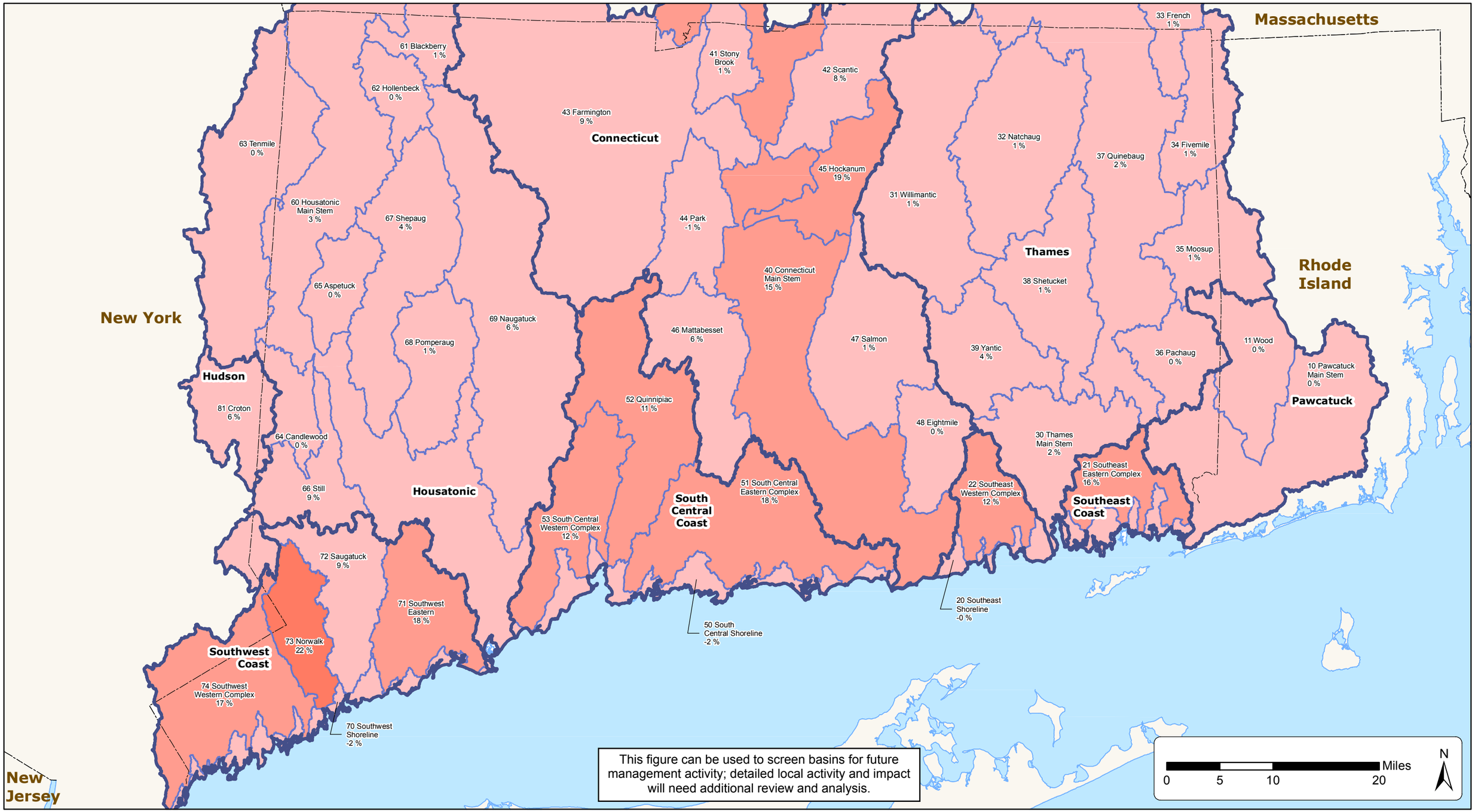


Figure 2-4
Average Annual Streamflow
Connecticut State Water Plan

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May, 2017



Legend

- Major Basin
- Regional Basin

Out-of-stream water needs and reservoir release requirements as a percent of average annual streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100

Figure 2-5

Out-of-stream Water Needs and Reservoir Release Requirements as a Percent of Average Annual Streamflow

Connecticut State Water Plan

CDM Smith | Milone & MacBroom®

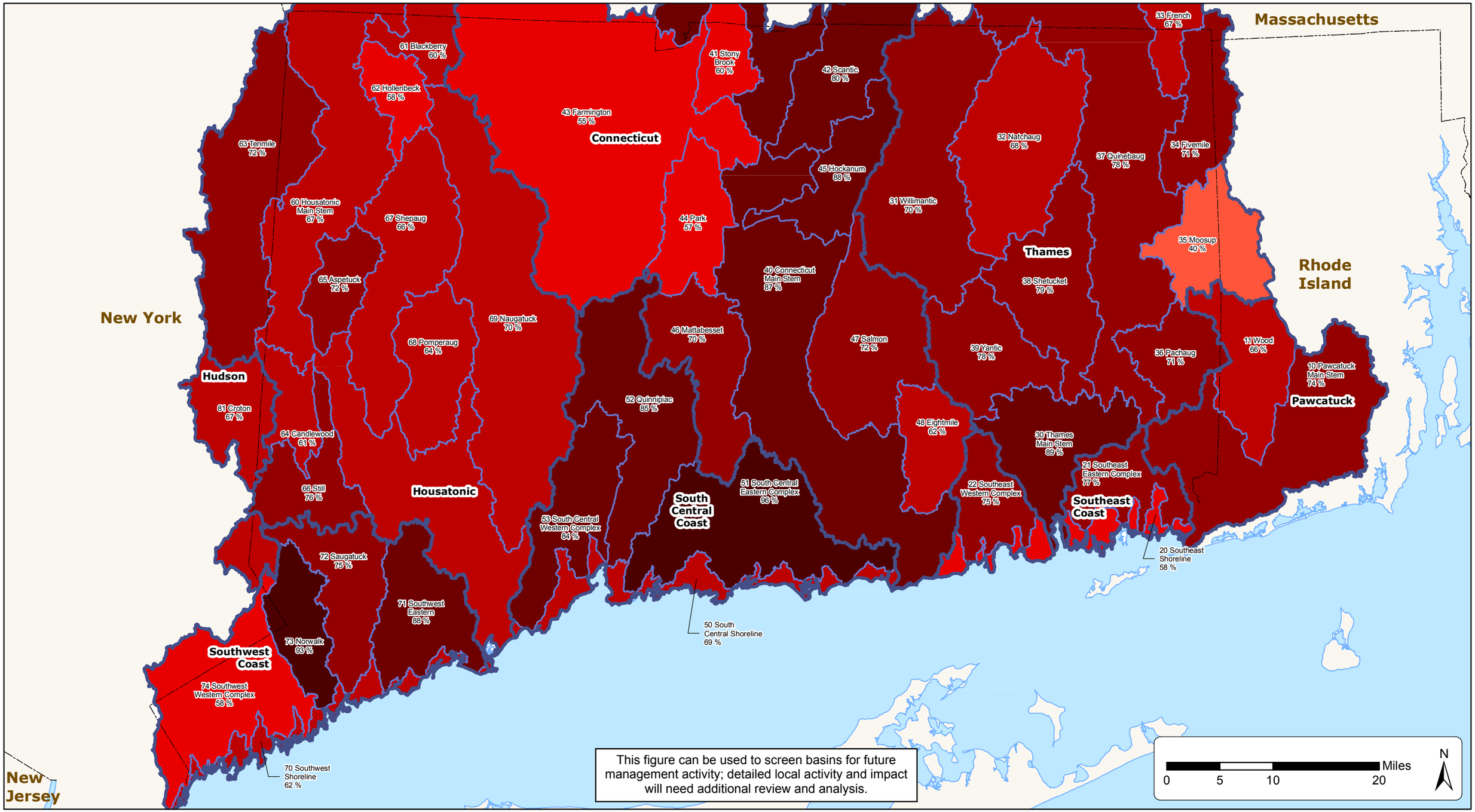
May, 2017

When instream needs are also considered, the potential ability of each basin to provide enough water for instream and out-of-stream needs changes significantly, as would be expected given that the Q50 is used to estimate the instream need. The combined out-of-stream and instream needs, as a percent of average annual streamflow for each regional basin, are shown in **Figure 2-6.** Note that the current reservoir releases are already included as a component of the instream water need. The highest percent of combined out-of-stream and instream water needs compared to streamflow occurs in the South Central Eastern Complex (96%), Norwalk (93%) and Thames Main Stem (89%). When considering all 44 regional basins, the average and median percent of combined out-of-stream and instream water needs compared to streamflow is 71%.

The comparison of current water needs to streamflow using average annual conditions suggests that there is plenty of water to meet out-of-stream needs in a normal year. When instream needs are also considered, no gaps appear even though nearly all the water is being used to satisfy a need in many regional basins. However, it is important to recognize that not all the water that flows in the basin may have sufficient quality for the intended use (Class A or AA, for example), or be available at the desired location. Furthermore, out-of-stream water needs are typically the highest during summer months at the same time when water availability may be at its lowest. Conversely, many basins include water that flows from upstream basins, and this most often is not accounted for in the water inventories (except in a few instances, the inventories account only for water that originates in the basin and could conceivably be put to any use at the outset of its journey through the hydrologic network). **Figure 2-7** illustrates this point by comparing a representative 30-year monthly average total streamflow in the Saugatuck regional basin to water demands from seven of Aquarion Water Company's public water supply and irrigation wells in the same basin. In this example, streamflow is the lowest in July and August at approximately 13 cubic feet per second (cfs), or about 33% of average annual flow. Conversely, demands are the highest in July, at just over 6 mgd – double the average annual demand. These seasonal imbalances in availability and demand emphasize both the need for and importance of storage, as provided by reservoirs and aquifers.

July water withdrawals from both surface water and groundwater and current required reservoir releases as a percent of average July streamflow for each regional basin are shown in **Figure 2-8**. The highest percent of water needs compared to July streamflow occurs in the Southeast Eastern Complex (226%), Norwalk (191%) and South Central Eastern Complex (150%). Total July water need is greater than 100% of streamflow in 4 of the 44 regional basins and greater than 50% of streamflow in 10 of 44 regional basins. This does not necessarily indicate an imminent water shortage – storage can provide buffers against this type of seasonality. But, the information is very useful in distinguishing basins that use significant percentages of summer flow to meet out-of-stream needs, from those that do not.

The combined out-of-stream and instream July water needs, as a percent of average July streamflow for each regional basin, are shown in **Figure 2-9.** In this case, the instream water need is based on the Q50 flow for July through October, not the Q80 flow (which is lower). Also, current reservoir releases are already included as a component of the instream water need. The highest percent of combined July out-of-stream and instream water needs compared to July streamflow occurs in the Southeast Eastern Complex (280%), Norwalk (254%) and South Central Eastern Complex (238%).



Legend

- Major Basin
- Regional Basin

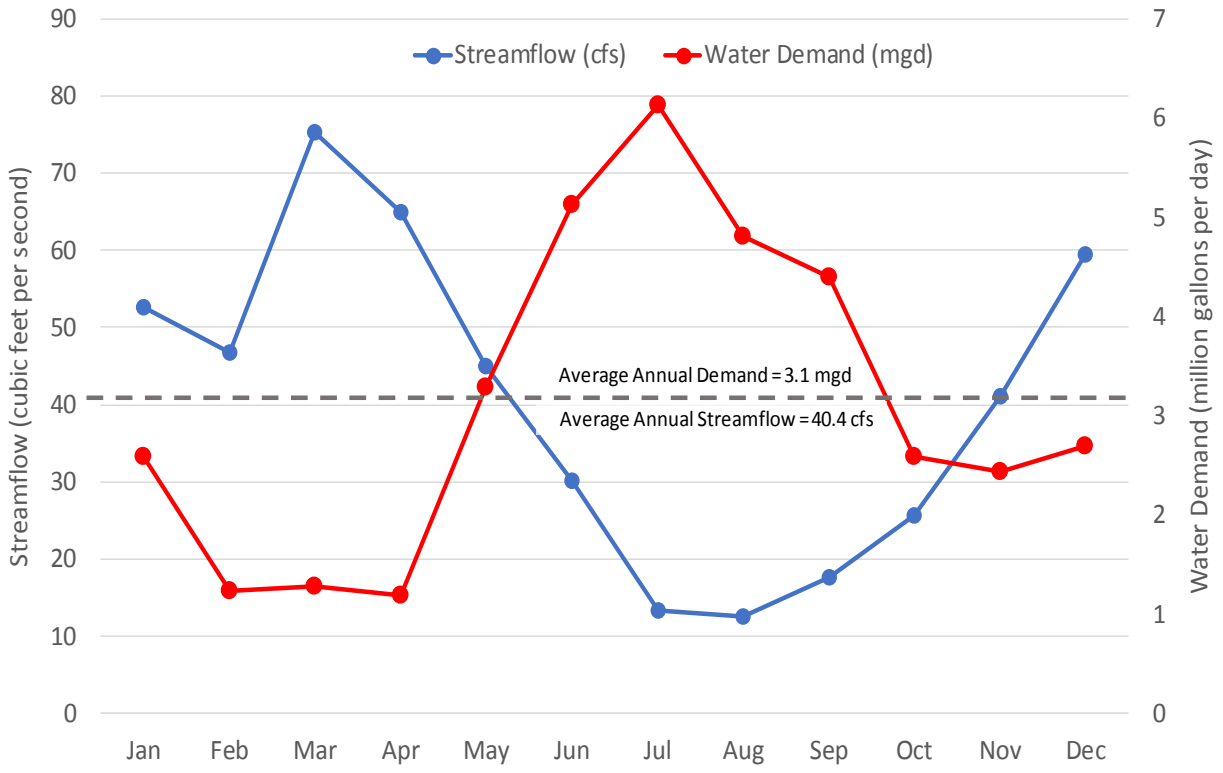
Out-of-stream and instream water needs as a percent of average annual streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100

Figure 2-6
Out-of-stream and Instream Water Needs as a Percent of Average Annual Streamflow
Connecticut State Water Plan

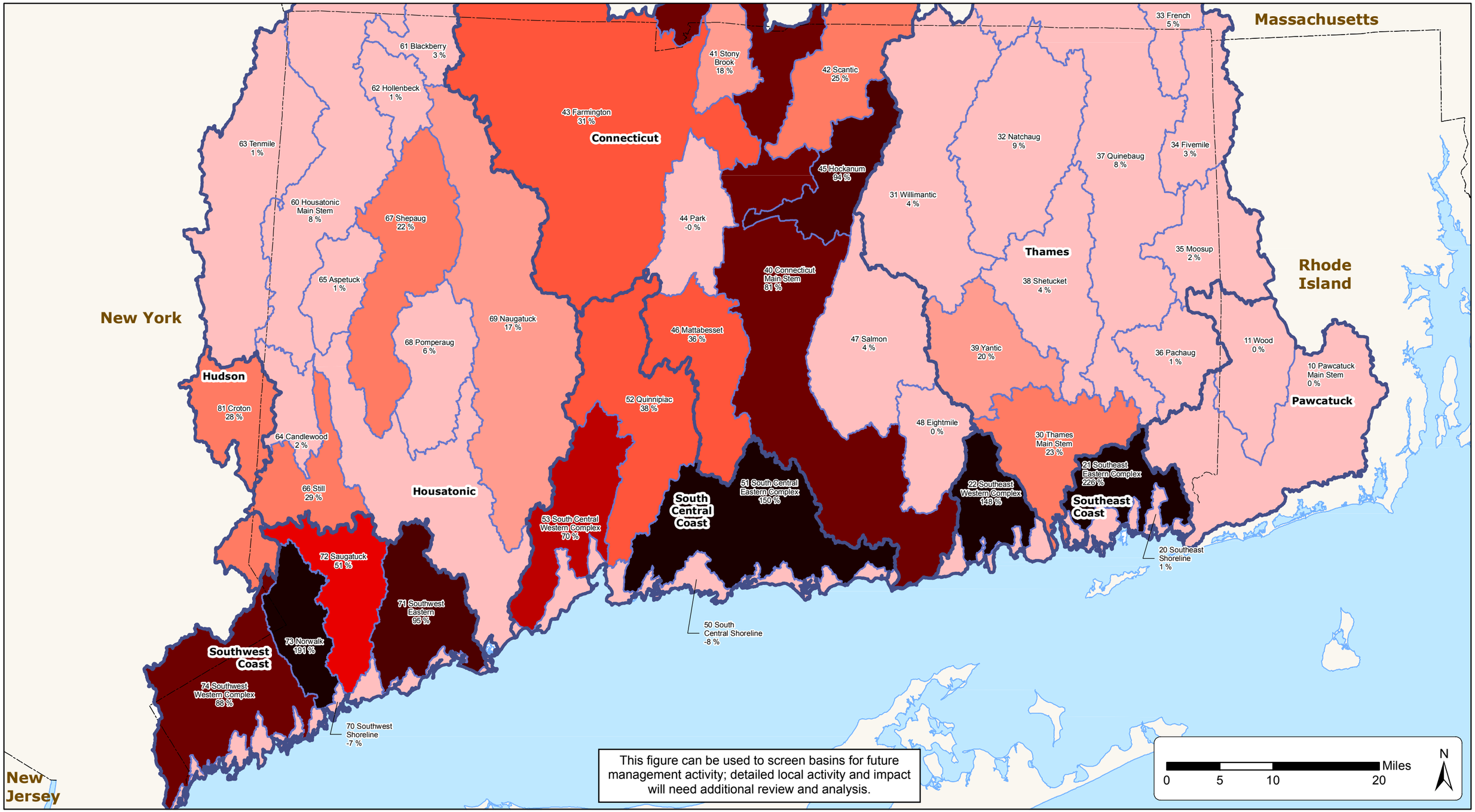
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Example streamflow and demand from the Saugatuck (No. 72) Regional Basin. Not all demands are included.

Figure 2-7. Comparison of Typical Seasonal Variations in Streamflow and Water Demand



Legend

- Major Basin
- Regional Basin

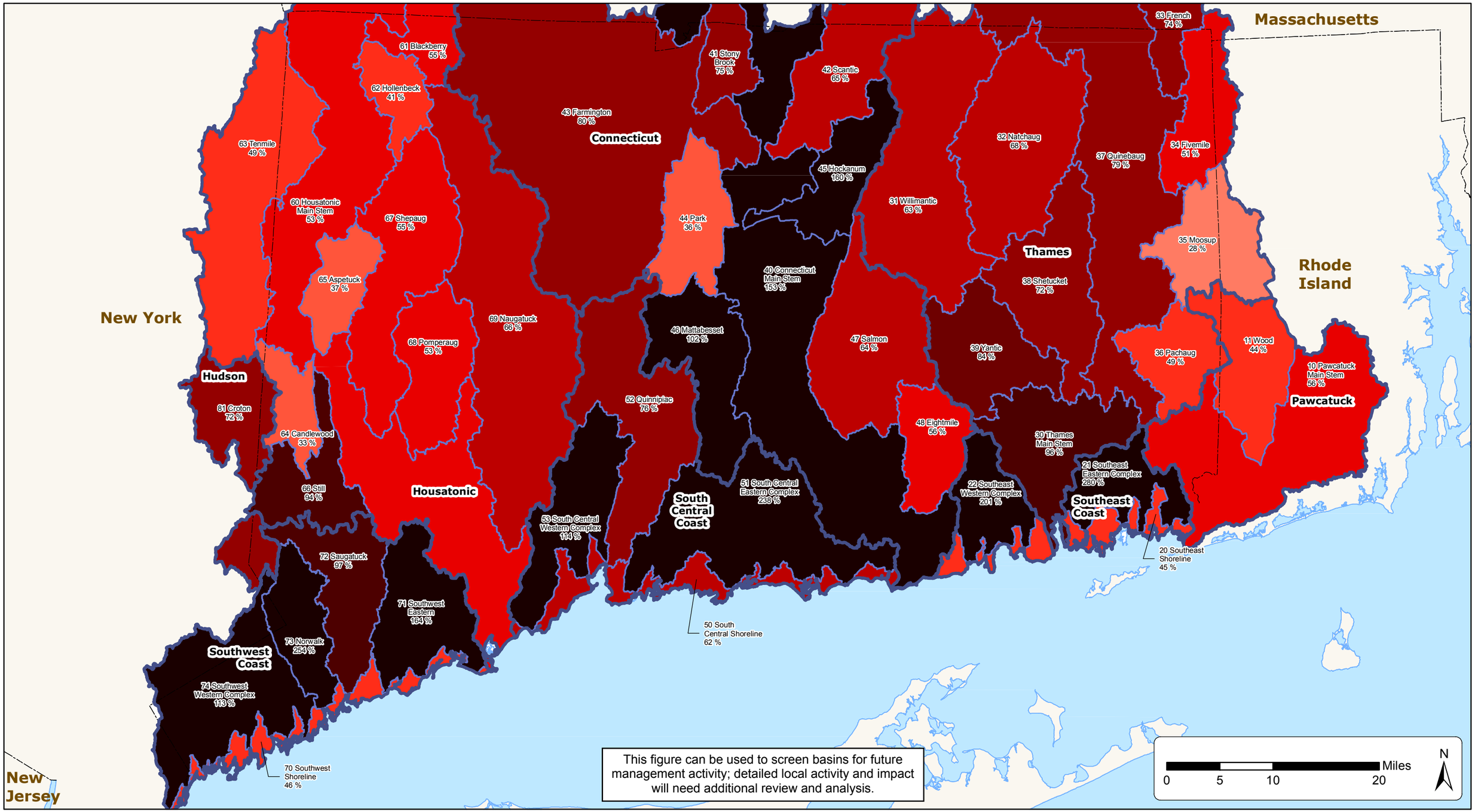
July out-of-stream water needs and reservoir release requirements as a percent of July streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90	> 100
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100	

Figure 2-8
July Out-of-stream Water Needs and Reservoir Release Requirements as a Percent of July Streamflow
Connecticut State Water Plan

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Legend

- Major Basin
- Regional Basin

July out-of-stream and instream water needs as a percent of July streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90	> 100	
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100		

Figure 2-9
Total July Out-of-stream and Instream Water Needs as a Percent of July Streamflow
Connecticut State Water Plan

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Usable Reservoir Storage

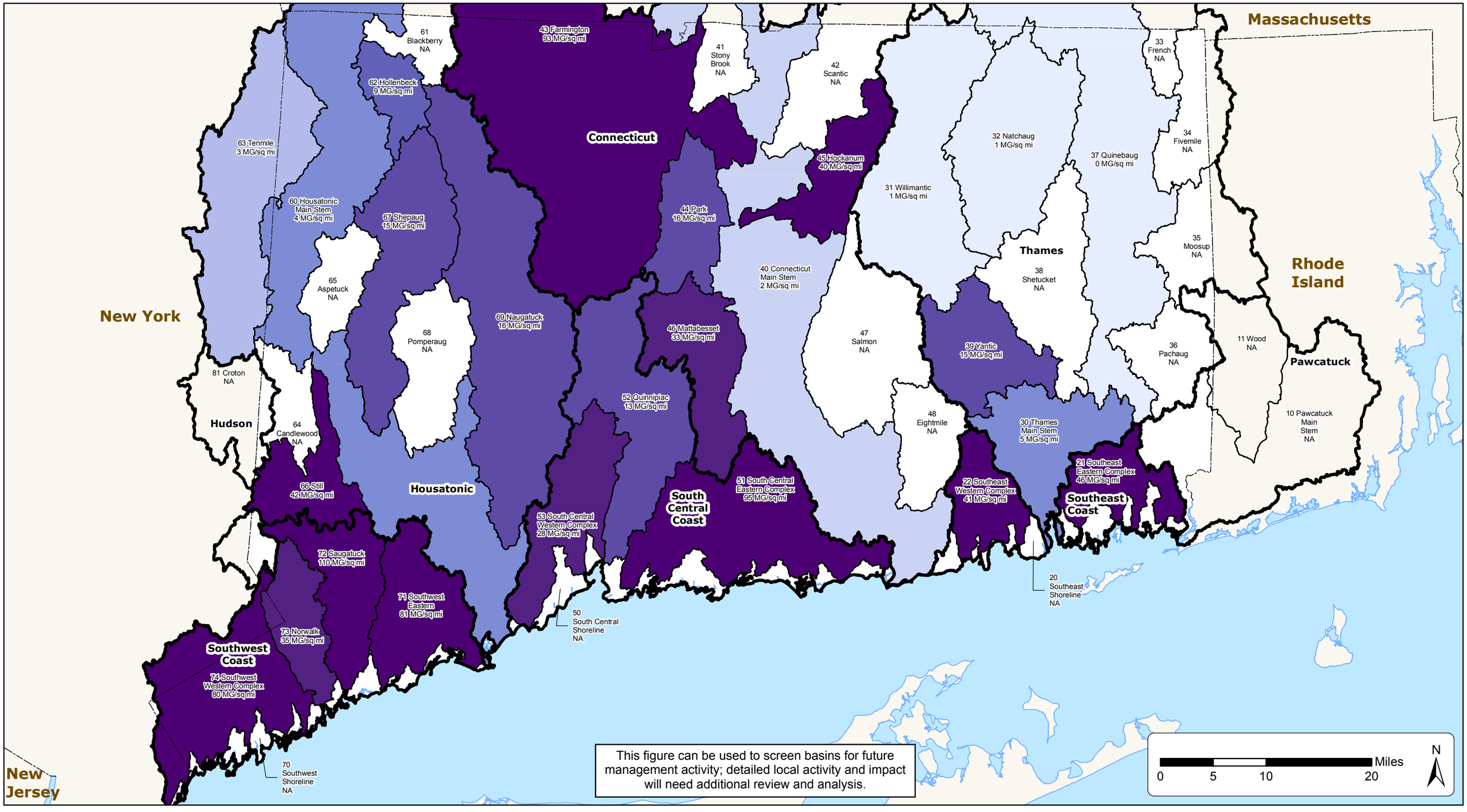
To assess the importance and adequacy of surface water storage, the amount of useable storage in water supply reservoirs was totaled for each regional basin, then divided by the regional basin size to provide a better means to compare relative storage between basins. Usable storage is the volume normally available for release from a reservoir below the stage of the maximum controllable level. **Figure 2-10** shows the amount of useable storage for each regional basin in million gallons per square mile. The months of usable storage at each regional basin's current average annual surface water demand is shown in **Figure 2-11**. This analysis assumes that storage is not replenished (no reservoir inflow) and also accounts for loss due to evaporation from the surface of the reservoir(s). **Figure 2-12** shows the months of usable storage at typical summer (July) demands to meet out-of-stream needs. Again, this analysis assumes that storage is not replenished, there is loss due to evaporation, and the rate of summer water need extends indefinitely. About one-third (8 of 25) of the regional basins with water supply reservoirs have less than 4 months of storage under these conditions.

By looking at the percent of water need to streamflow (e.g., Figures 2-5, 2-6, 2-8 and 2-9) and the amount or days of storage (e.g., Figures 2-11 and 2-12), the regional basins where water shortages are most likely to occur and where the potential for stress is the highest, can be identified. Similarly, basins which contain a comparatively large amount of storage and are less prone to shortages will also become apparent. For example, the Southeast Eastern Complex, Norwalk and South East Western Complex had some of the highest percent of July water needs for out-of-stream use and to meet reservoir release requirements, compared to July streamflow (see Figure 2-8). These three regional basins also have less than 3 months of usable storage each at summer peak demands. Conversely, the South Central Eastern Complex, which had the third highest percentage of July water demand compared to streamflow has 9 months of usable storage at summer peak demands. This and similar basins may be less prone to future inability to satisfy all water needs.

Other factors must also be considered when assessing water availability. Prolonged droughts may significantly lower BF and limit SF, greatly reducing the amount of water in a basin. Poor water quality may limit the amount of water that is available for certain uses without treatment. For these reasons, the water inventory and assessment of surface water storage does not completely characterize current conditions. The significance of these other factors in limiting water availability are evaluated in subsequent sections of the Plan, beginning with an overview of current water quality.

2.1.5 Current Water Quality throughout Connecticut

Numerous studies have examined the quality of Connecticut's waters dating back over 40 years and prior to the establishment of the Clean Water Act (CWA) in 1972. The Integrated Water Quality Report (IWQR) prepared by DEEP provides one of the more suitable and comprehensive assessments of water quality conditions in the state's lakes, rivers, estuaries and groundwater. The report is produced every two years per requirements to Sections 305(b) and 303(d) of the CWA.



Legend

- Major Basin
- Regional Basin

Usable storage per area (MG/sq mi)

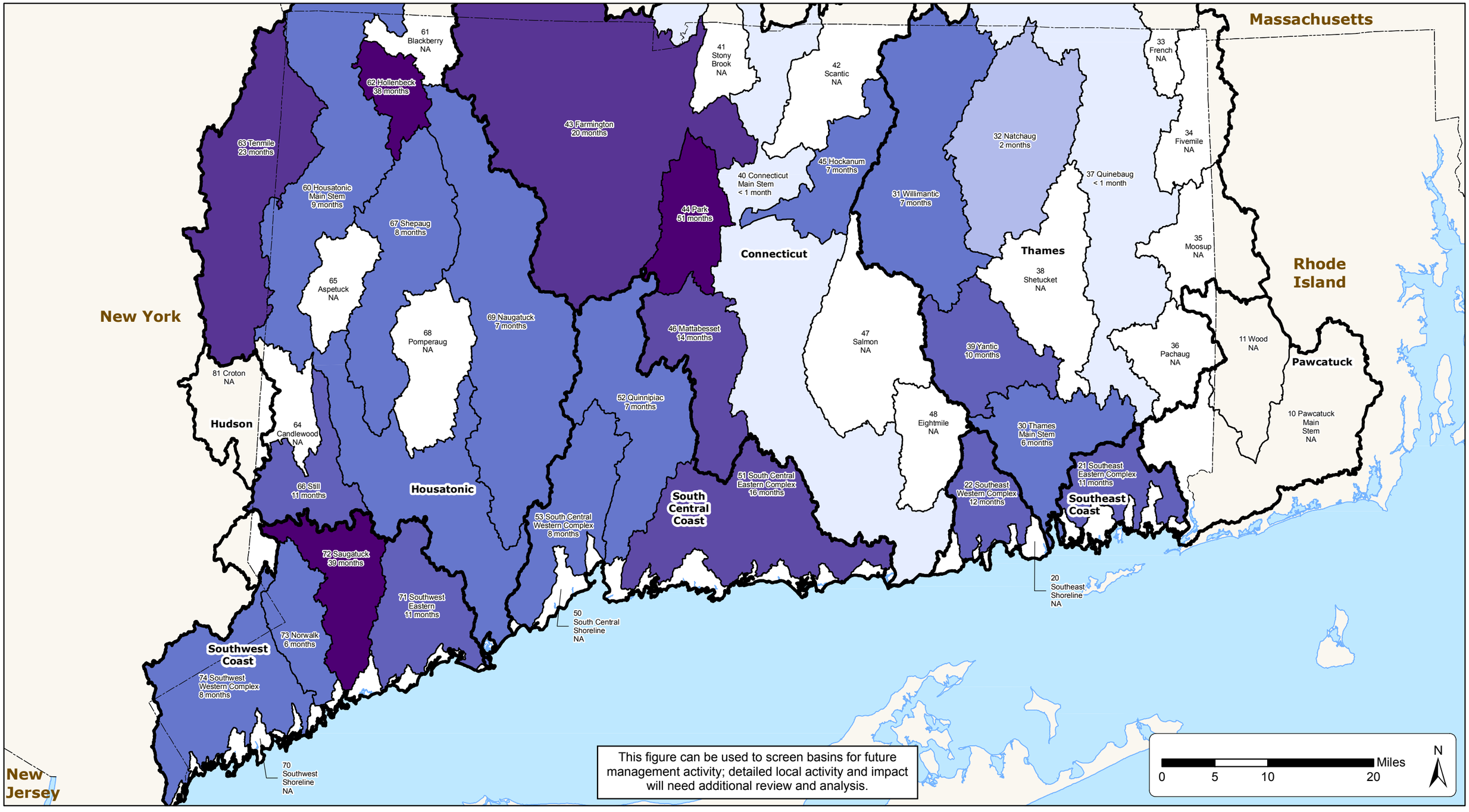
0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 6 | 6 - 9 | 9 - 12 | 12 - 18 | 18 - 24 | 24 - 36 | > 36

NA = Not Applicable (No Water Supply Reservoirs)

Figure 2-10
Usable Storage per Area (MG/sq mi)
Connecticut State Water Plan

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Legend

- Major Basin
- Regional Basin

Months of usable storage at current average annual out-of-stream water demand

0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 6 | 6 - 9 | 9 - 12 | 12 - 18 | 18 - 24 | 24 - 36 | > 36

NA = Not Applicable (No Water Supply Reservoirs)

Figure 2-11
Months of Usable Storage at Current Average Annual Out-of-stream Water Demand
Connecticut State Water Plan

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Massachusetts

Rhode Island

New York

New Jersey

Connecticut

61 Blackberry NA

62 Hollenbeck 32 months

63 Tenmile 18 months

60 Housatonic Main Stem 6 months

65 Aspetuck NA

67 Shepaug 7 months

68 Pomperaug NA

69 Naugatuck 6 months

81 Croton NA

Hudson

64 Candlewood NA

66 Still 10 months

Housatonic

72 Saugatuck 30 months

71 Southwest Eastern 8 months

73 Norwalk 2 months

Southwest Coast

74 Southwest Western Complex 6 months

70 Southwest Shoreline NA

43 Farmington 16 months

41 Stony Brook NA

42 Scantic NA

44 Park 35 months

40 Connecticut Main Stem < 1 month

45 Hockanum 5 months

46 Mattabesset 9 months

52 Quinnipiac 4 months

53 South Central Western Complex 4 months

50 South Central Shoreline NA

51 South Central Eastern Complex 9 months

South Central Coast

31 Willimantic 6 months

47 Salmon NA

48 Eightmile NA

32 Natchaug 1 months

39 Yantic 6 months

30 Thames Main Stem 1 months

22 Southeast Western Complex 2 months

20 Southeast Shoreline NA

Thames

38 Shetucket NA

37 Quinebaug < 1 month

21 Southeast Eastern Complex 3 months

Southeast Coast

33 French NA

34 Fivemile NA

35 Moosup NA

36 Pachaug NA

11 Wood NA

Pawcatuck

10 Pawcatuck Main Stem NA

This figure can be used to screen basins for future management activity; detailed local activity and impact will need additional review and analysis.

0 5 10 20 Miles

N

Legend

Major Basin

Regional Basin

Months of usable storage at current July out-of-stream water demand

0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 6 | 6 - 9 | 9 - 12 | 12 - 18 | 18 - 24 | 24 - 36 | > 36

NA = Not Applicable (No Water Supply Reservoirs)

Figure 2-12

Months of Usable Storage at Current July Out-of-stream Water Demand

Connecticut State Water Plan

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In preparing the IWQR, DEEP monitors and assesses the quality of waterbodies relative to the attainment of designated uses established by the State's Water Quality Standards. Additionally, the state uses the monitoring results to identify and prioritize water quality limited waterbodies and develop Total Maximum Daily Loads (TMDLs) or other management actions consistent with the Water Quality Standards. The waterbodies are assessed on a rotating basis.

Statewide, improvements to water quality have been observed over the last several decades due to improved and expanded treatment of wastewater, remediation of polluted waters, and protective laws and regulations. Nevertheless, there is still work to be done to improve water quality in Connecticut, particularly in the areas of stormwater and nutrient management.

2.1.5.1 Assessment of Designated Uses

In authorizing the CWA, Congress declared as a national goal the attainment, wherever possible, of "water quality, which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water". In preparing the IWQR, DEEP assesses whether the waters of the state meet the designated uses by categorizing them into the following levels of support: fully supporting, not supporting, or not assessed.

Recreation Designated Use

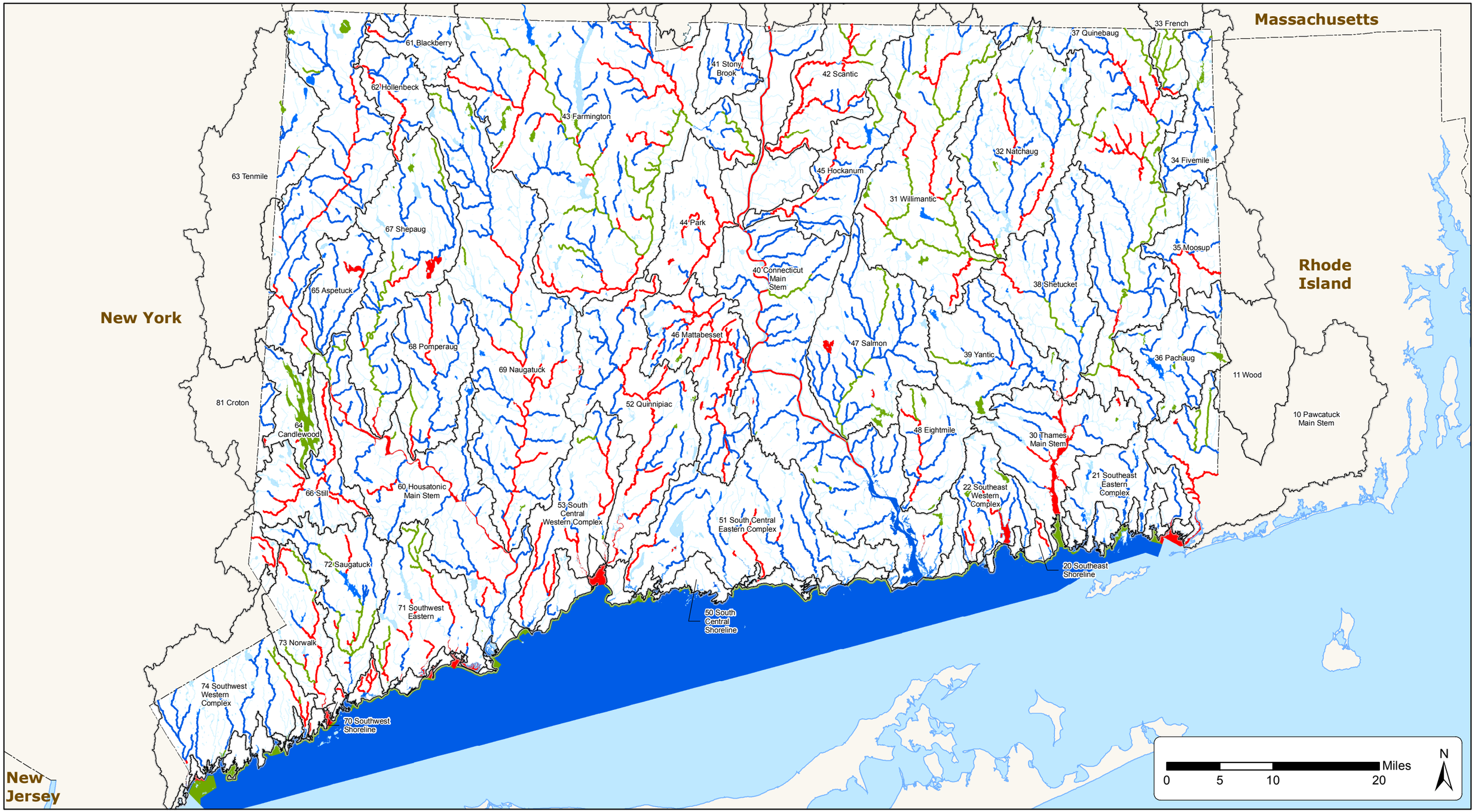
In order to meet the designated use of recreation, waterbodies are assessed based on factors that consider both sanitary conditions and aesthetic usability. Sanitary conditions are largely determined by the presence or absence of fecal indicator bacteria from samples, but supplemented by other means, including sanitary surveys and inspections of shorelines and watersheds for evidence of contamination or a known CSO. Aesthetic considerations include excessive aquatic invasive plants or algae, which may be an indicator of excessive nutrients in the waterbody. The waterbodies (rivers, streams, lakes, reservoirs, ponds, estuaries and bays) that were most recently identified as supporting, not supporting, or not assessed for recreational use are shown in **Figure 2-13**.

Aquatic Life Designated Use

DEEP uses a combination of information on the benthic macroinvertebrate community, fish community, physical/chemical data, toxicity, and records of water quantity to make an aquatic life use support determination for wadeable rivers and streams. For lakes, reservoirs and ponds, factors taken into consideration include known problems such as chronic algal blooms, the extent of coverage by exotic invasive plants, severe sedimentation, fish surveys, and the trophic status of the waterbody based on ambient measurements of total phosphorous, total nitrogen, chlorophyll a, and water transparency. The waterbodies that were most recently identified as supporting, not supporting, or not assessed for aquatic life use are shown in **Figure 2-14**.

Drinking Water Supply and Other Designated Uses

Waterbodies are also subject to and evaluated for other designated uses, including for drinking water supply, agricultural and industrial use, navigation, shellfish harvesting (in estuaries), and fish consumption. Lacking evidence to the contrary, DEEP presumes that drinking water use is fully supporting for all Class AA reservoirs and tributaries when filtration and disinfection are reliably maintained and operated (descriptions of water quality classifications, including AA, are included in Table 2-2 later in this section). Class AA waters are regulated by programs at DPH that



Legend

- Regional Basin
- Major Waterbody

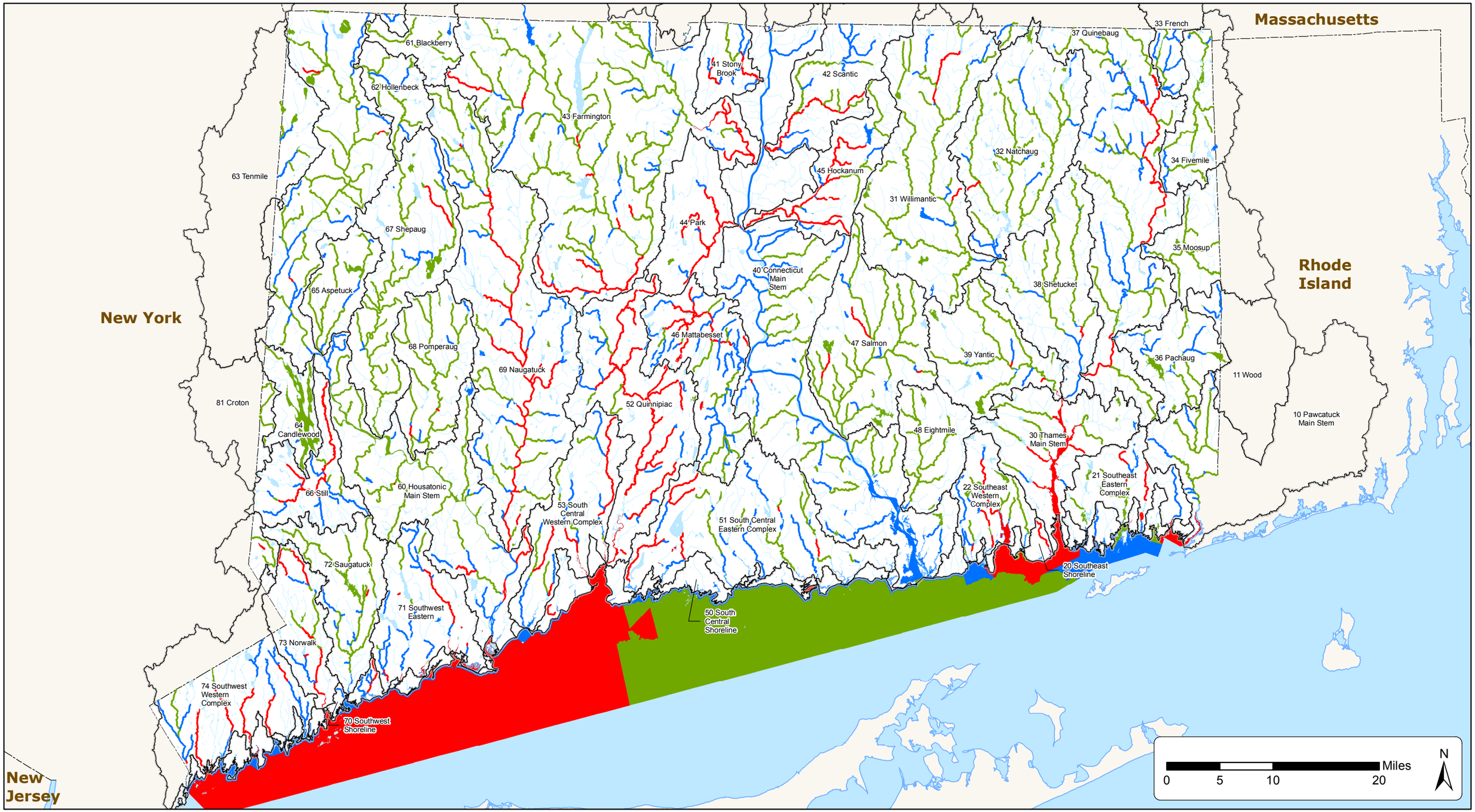
2016 Connecticut Recreational Use Support

- Fully Supporting (397.74 miles)
- Not Supporting (828.76 miles)
- Unassessed (1,756.23 miles)

Figure 2-13
2016 Connecticut Recreational Use Support
Connecticut State Water Plan

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Legend

- Regional Basin
- Major Waterbody

2016 Connecticut Aquatic Life Use Support

- Fully Supporting (1,619.85 miles)
- Not Supporting (544.33 miles)
- Unassessed (818.54 miles)

Figure 2-14
2016 Connecticut Aquatic Life Use Support
Connecticut State Water Plan

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coordinate, manage, and ensure treatment and source protection through oversight of existing laws and regulations, coupled with water supply planning, education, and stakeholder involvement. Waterbodies serving as supply for agricultural use are assumed to be fully supported for all Class AA, A, and B waters and industrial use is assumed to be fully supported for all AA, A, B, SA and SB waters.

2.1.5.2 Water Quality Standards and Classifications

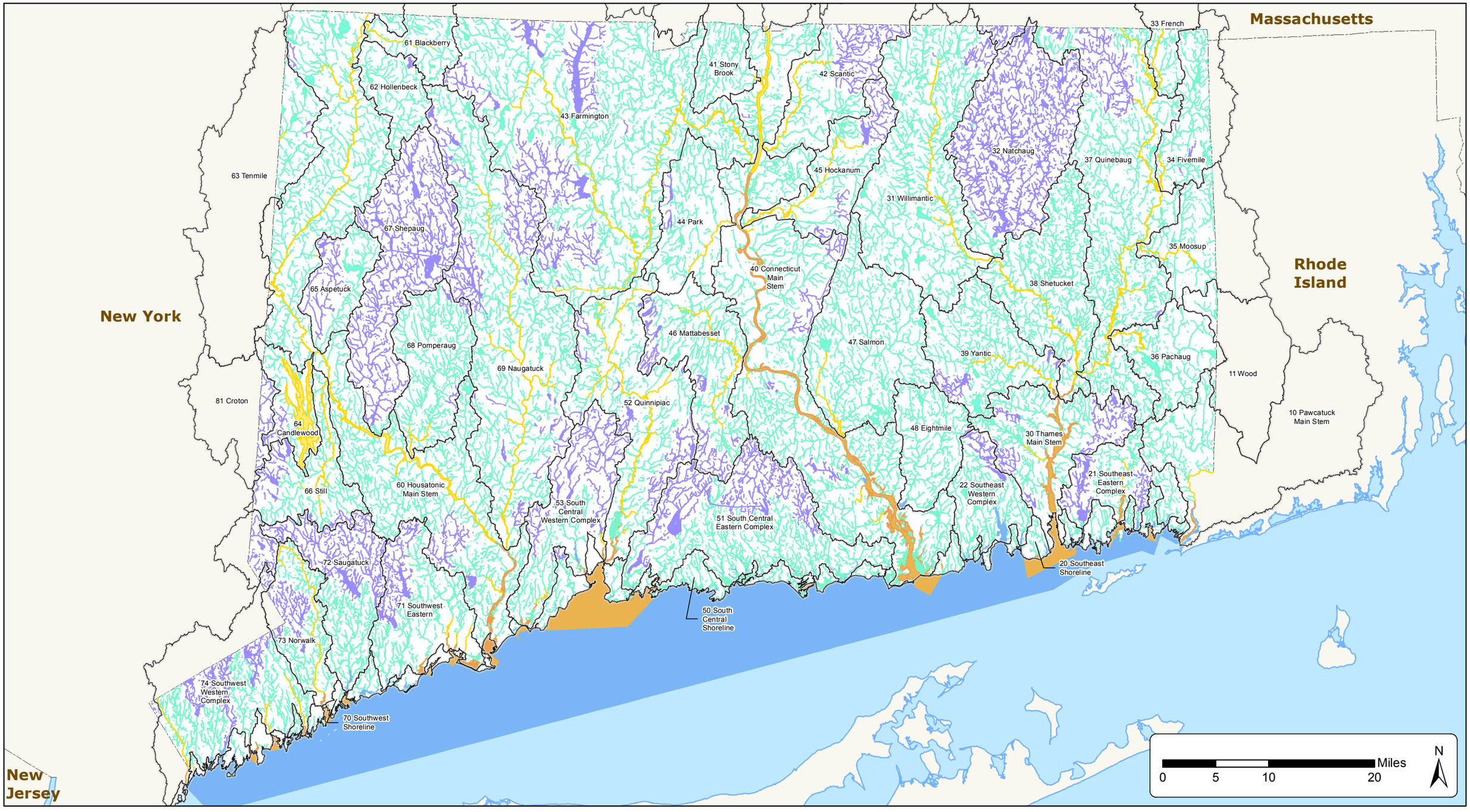
Connecticut's water quality standards and classifications serve as the backbone of the state's clean water program. The standards and classifications serve numerous purposes, including:

- providing guidance and policy about water quality in the state and DEEP's goals for maintaining or improving that quality;
- establishing designated uses of surface and ground water;
- indicating the general types of discharges allowed;
- ensuring the segregation of drinking water supplies from waters used for waste assimilation;
- providing the standards to protect aquatic life and human use;
- providing a framework for the establishment of priorities for pollution abatement, dispensation of state funding, remediation goals; and
- providing guidance for location decisions for business and industry as well as other economic developments.

Water quality classifications have been established for surface water resources throughout the state. The designated uses and allowable discharges for each class are detailed in **Table 2-2**. Both inland and coastal/marine surface water resource classifications are shown on **Figure 2-15**. **Table 2-3** provides a regional basin-level summary of the relative amount (in percent) of each inland surface water class of waterbody. Groundwater classifications and areas contributing to public supply wells are shown on **Figure 2-16**. **Table 2-4** provides a regional basin-level summary of the relative amount (in percent) of each class of groundwater.

Table 2-2. Connecticut Water Quality Classifications

Inland Surface Waters	
Class AA	Designated uses: existing or proposed drinking water supply, fish and wildlife habitat, recreational use (may be restricted,) agricultural and industrial supply. Discharges restricted to: discharges from public or private drinking water treatment systems, dredging and dewatering, emergency and clean water discharges.
Class A	Designated uses: potential drinking water supply; fish and wildlife habitat; recreational use; agricultural and industrial supply and other legitimate uses including navigation. Discharges restricted to: same as allowed in AA.
Class B	Designated uses: recreational use: fish and wildlife habitat; agricultural and industrial supply and other legitimate uses including navigation. Discharges restricted to: same as allowed in A and cooling waters, discharges from industrial and municipal wastewater treatment facilities (providing Best Available Treatment and Best Management Practices are applied), and other discharges subject to the provisions of section 22a-430 CGS
Coastal and Marine Surface Waters	
Class SA	Designated uses: marine fish, shellfish and wildlife habitat, shell fish harvesting for direct human consumption, recreation and all other legitimate uses including navigation. Discharges restricted to: same as for AA or A surface waters.
Class SB	Designated uses: marine fish, shellfish and wildlife habitat, shellfish harvesting for transfer to approved areas for purification prior to human consumption, recreation, industrial and other legitimate uses including navigation. Discharges restricted to: same as for B surface waters.
Groundwater	
Class GAA	Designated uses: existing or potential public supply of water suitable for drinking without treatment; baseflow for hydraulically connected surface water bodies. Discharges limited to: treated domestic sewage, certain agricultural wastes, certain water treatment wastewaters.
Class GA	Designated uses: existing private and potential public or private supplies of water suitable for drinking without treatment; baseflow for hydraulically connected surface water bodies. Discharges restricted to: as for GAA and discharge from septage treatment facilities subject to stringent treatment and discharge requirements, and other wastes of natural origin that easily biodegrade and present no threat to groundwater.
Class GB	Designated uses: industrial process water and cooling waters; baseflow for hydraulically connected surface water bodies; presumed not suitable for human consumption without treatment. Discharges restricted to: same as for A (Note; same treatment standards apply), certain other biodegradable wastewaters subject to soil attenuation.
Class GC	Designated uses: assimilation of discharge authorized by the Commissioner pursuant to Section 22a-430 of the General Statutes. As an example a lined landfill for disposal of ash residue from a resource recovery facility. The GC hydrogeology and hydrologic setting provides the best safeguard to adjacent resources. Discharges restricted to: potential discharges from certain waste facilities subject to specific permitting requirements.



Legend

- Regional Basin
- Major Waterbody

Connecticut Surface Water Class

- A
- AA
- B, B*
- SA
- SB

Figure 2-15
Connecticut Surface Water Class
Connecticut State Water Plan

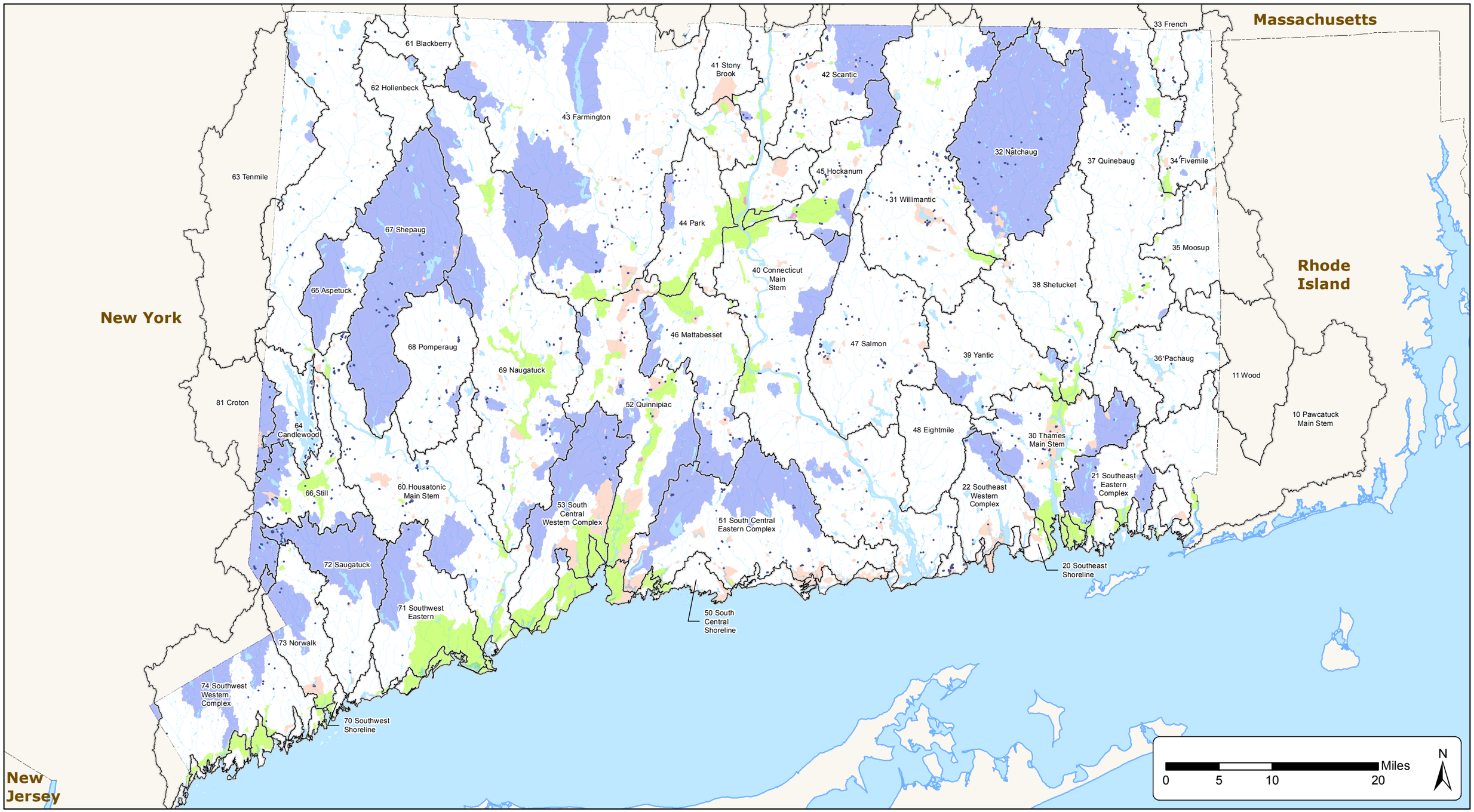
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Table 2-3. Surface Water Class Summary for Inland Waters

Regional Basin		Percent (of miles or acres) by Inland Water Class					
		Rivers & Streams			Lakes, Reservoirs and Ponds		
No.	Name	A	AA	B,B*	A	AA	B,B*
10	Pawcatuck Main Stem	100%	0%	0%	90%	0%	10%
11	Wood	99%	0%	0%	100%	0%	0%
20	Southeast Shoreline	98%	0%	0%	100%	0%	0%
21	Southeast Eastern Com.	63%	34%	3%	26%	73%	1%
22	Southeast Western Com.	89%	11%	0%	57%	43%	0%
30	Thames Main Stem	69%	30%	1%	55%	42%	3%
31	Willimantic	96%	4%	1%	84%	4%	12%
32	Natchaug	6%	94%	0%	2%	98%	0%
33	French	95%	0%	5%	45%	0%	55%
34	Fivemile	97%	3%	0%	87%	6%	7%
35	Moosup	100%	0%	0%	80%	0%	20%
36	Pachaug	100%	0%	0%	86%	0%	14%
37	Quinebaug	81%	18%	1%	42%	15%	43%
38	Shetucket	100%	0%	0%	58%	3%	39%
39	Yantic	91%	9%	0%	67%	24%	8%
40	Connecticut Main Stem	93%	6%	1%	46%	8%	46%
41	Stony Brook	100%	0%	0%	95%	0%	5%
42	Scantic	50%	50%	0%	41%	31%	29%
43	Farmington	78%	21%	1%	34%	52%	15%
44	Park	90%	5%	6%	65%	32%	2%
45	Hockanum	62%	29%	9%	18%	56%	26%
46	Mattabesset	74%	24%	2%	42%	46%	13%
47	Salmon	98%	0%	2%	89%	0%	11%
48	Eightmile	99%	1%	0%	98%	2%	0%
50	South Central Shoreline	95%	1%	0%	78%	22%	0%
51	South Central Eastern Com.	64%	35%	0%	29%	71%	0%
52	Quinnipiac	71%	16%	12%	40%	39%	21%
53	South Central Western Com.	47%	53%	1%	27%	67%	5%
60	Housatonic Main Stem	93%	5%	1%	45%	5%	50%
61	Blackberry	87%	0%	13%	97%	0%	3%
62	Hollenbeck	100%	0%	0%	40%	60%	0%
63	Tenmile	96%	2%	2%	94%	5%	1%
64	Candlewood	74%	26%	0%	3%	2%	96%
65	Aspetuck	51%	49%	0%	75%	25%	0%
66	Still	78%	18%	4%	20%	71%	9%
67	Shepaug	1%	99%	0%	5%	95%	0%
68	Pomperaug	95%	4%	1%	76%	18%	6%
69	Naugatuck	75%	24%	2%	51%	32%	18%
70	Southwest Shoreline	69%	0%	1%	100%	0%	0%
71	Southwest Eastern	69%	25%	2%	35%	62%	3%
72	Saugatuck	44%	56%	0%	18%	82%	0%
73	Norwalk	59%	31%	10%	36%	51%	12%
74	Southwest Western Com.	69%	26%	5%	33%	62%	5%
81	Croton	0%	100%	0%	0%	100%	0%

Source: GIS files of CT water quality classifications, as provided by CT DEEP.



Legend

- Regional Basin
- Major Waterbody

Connecticut Groundwater Class

- GA
- GAA, GAAs
- GB
- GC
- GA, GAA May be impaired
- Area of Contribution to Public Supply Well

Figure 2-16
Connecticut Groundwater Class
Connecticut State Water Plan

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Table 2-4. Groundwater Class Summary

Regional Basin		Percent (of acres), by Groundwater Class				
No.	Name	GA	GAA	GB	GC	GA, GAA may be impaired
10	Pawcatuck Main Stem	97%	0%	2%	0%	1%
11	Wood	100%	0%	0%	0%	0%
20	Southeast Shoreline	76%	0%	15%	0%	8%
21	Southeast Eastern Com.	62%	32%	4%	0%	2%
22	Southeast Western Com.	80%	14%	0%	0%	6%
30	Thames Main Stem	55%	27%	10%	0%	8%
31	Willimantic	92%	4%	1%	0%	3%
32	Natchaug	5%	93%	0%	0%	1%
33	French	96%	1%	2%	0%	1%
34	Fivemile	92%	4%	3%	0%	1%
35	Moosup	98%	0%	1%	0%	1%
36	Pachaug	98%	0%	1%	0%	1%
37	Quinebaug	81%	16%	2%	0%	1%
38	Shetucket	95%	1%	3%	0%	1%
39	Yantic	87%	10%	2%	0%	1%
40	Connecticut Main Stem	86%	6%	5%	0%	2%
41	Stony Brook	89%	0%	0%	0%	11%
42	Scantic	59%	38%	1%	0%	3%
43	Farmington	73%	23%	2%	0%	2%
44	Park	77%	6%	15%	0%	2%
45	Hockanum	54%	28%	15%	0%	2%
46	Mattabesset	68%	22%	8%	0%	2%
47	Salmon	97%	1%	0%	0%	2%
48	Eightmile	99%	1%	0%	0%	0%
50	South Central Shoreline	48%	2%	36%	0%	14%
51	South Central Eastern Com.	54%	39%	1%	0%	6%
52	Quinnipiac	59%	17%	14%	0%	10%
53	South Central Western Com.	27%	48%	14%	0%	11%
60	Housatonic Main Stem	91%	5%	3%	0%	1%
61	Blackberry	100%	0%	0%	0%	0%
62	Hollenbeck	98%	2%	0%	0%	0%
63	Tenmile	96%	4%	0%	0%	0%
64	Candlewood	78%	21%	0%	0%	1%
65	Aspetuck	49%	50%	0%	0%	0%
66	Still	65%	23%	10%	0%	2%
67	Shepaug	1%	98%	0%	0%	1%
68	Pomperaug	94%	5%	0%	0%	1%
69	Naugatuck	71%	22%	6%	0%	1%
70	Southwest Shoreline	60%	0%	40%	0%	0%
71	Southwest Eastern	52%	22%	25%	0%	0%
72	Saugatuck	42%	57%	0%	0%	0%
73	Norwalk	66%	25%	4%	0%	5%
74	Southwest Western Com.	70%	26%	4%	0%	1%
81	Croton	0%	96%	0%	0%	4%

Source: GIS files of CT water quality classifications, as provided by CT DEEP.

2.1.5.3 Causes of Water Quality Impairments and Drinking Water Quality Violations

The most common causes of water quality impairments vary by water body type. **Figure 2-17** summarizes the most common causes of impairments based on the 2016 IWQR. In flowing waters (i.e., rivers and streams), indicator bacteria account for more than half of the impairments. For biological impairments in flowing waters, additional work is often needed to determine the most probable cause of impairments, and these are listed as "cause unknown". The causes of impairments to lakes, reservoirs and ponds are more diverse, and most commonly include nutrients, algal growth (caused by nutrients), and polychlorinated biphenyls (PCBs). Estuary and bay water quality is most often compromised by oxygen depletion, nutrients, and/or indicator bacteria.

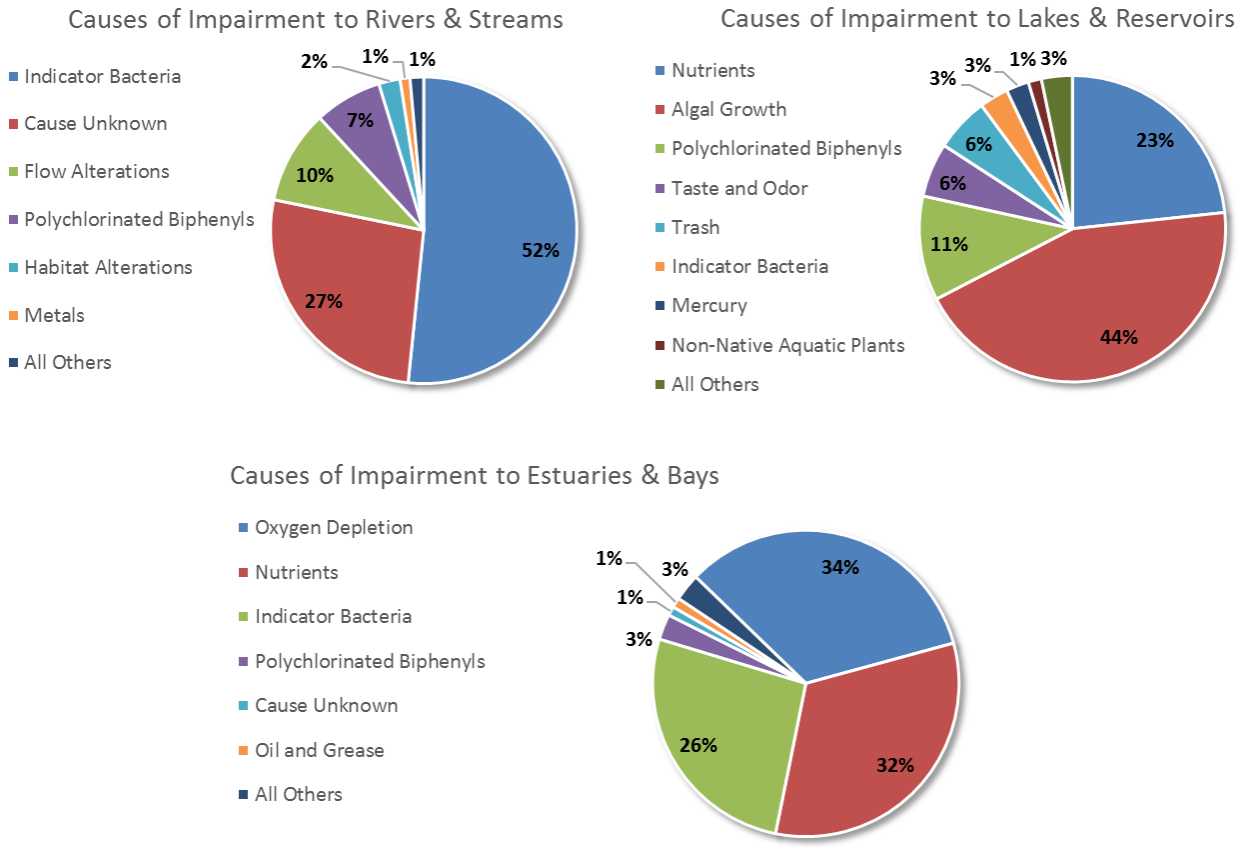


Figure 2-17. 2014 Causes of Impairment Summary for Connecticut's Assessed Waters
(Source: Connecticut Water Quality Assessment Report, EPA webpage)

Nutrients, primarily phosphorus and nitrogen, impair both aquatic life and recreational use of Connecticut's waterbodies and is a serious threat to water quality in Connecticut. Excessive loading of nutrients to surface waters due to wastewater discharges, stormwater or non-point sources such as runoff from urban and agricultural lands, or other sources, can lead to algal blooms, including blooms of noxious blue green algae, reduction in water clarity, habitat modification, aquatic life impairments and in extreme cases depletion of oxygen and fish kills. Nutrient reductions have been targeted for discharges of both phosphorus and nitrogen to address water quality concerns.

The recently released Preliminary Water Supply Assessments for the Western, Central and Eastern Public Water Supply Management Areas provide a summary of recent public water supply quality violations and water quality concerns, as noted in water supply plans. Water quality violations for finished (treated) water, of which there are relatively very few, were most typically associated maximum contaminant level exceedances of total coliform. Nitrite, nitrate, lead, copper, arsenic, total trihalomethanes (TTHMs), net gross alpha, uranium, and chloride exceedances were also noted. The water quality concerns cited in the water supply plans are associated with constituents that require treatment or activities within the source water area that could affect water quality. Elevated iron and manganese levels are commonly cited as a concern. The source of these two metals is mostly attributed to the weathering of minerals in parts of the soil or aquifer where concentrations of dissolved oxygen are low, although mobilization can be enhanced by low pH or by bonding with organic compounds. Many public water suppliers located in the more urban areas are also concerned about, and actively treating for volatile organic compounds (VOCs). Source protection concerns are most often associated with nitrates from failing septic systems and agricultural activity; roadway runoff, especially associated deicing chemicals and salts; leaking underground storage tanks; erosion; and industrial and commercial spills. Water quality concerns for private wells are generally the same as those from public supply wells.

2.1.5.4 Planning for the Future

To continue to make progress in improving water quality, DEEP estimates that over $5B will be needed for wastewater infrastructure improvements over the next 20 years. The most significant projects include the elimination of CSOs, denitrification of wastewater necessary to improve conditions in Long Island Sound, and emerging issues such as phosphorous removal. Infrastructure improvements to address both quantity and quality issues are discussed in the following section.

2.1.6 Current Infrastructure Capacity and Planned Improvements

Water infrastructure in Connecticut varies widely according to purpose and need. In general, water infrastructure includes supply, treatment, transmission, and distribution systems for public water systems, industries, agriculture, and other users; and collection, treatment, conveyance, and discharge systems for stormwater and wastewater. Within these two categories are numerous individual types of infrastructure. Current (2016) water infrastructure in Connecticut includes:

- 47 surface water treatment plants used by the state's largest public water systems (considering large public water systems as those that serve over 1,000 individuals)
- 150 public water supply reservoirs and surface water diversions, many of which are supported by dams
- Hundreds of water supply wells used by the state's largest public water systems
- Hundreds of major water storage tanks for potable water supply from the state's largest public water systems
- Distribution systems and hydrants associated with the state's largest public water systems

- Water supply wells, tanks, and pumps associated with 330 small community water systems
- Water supply wells, tanks, and pumps associated with 547 non-transient non-community water systems
- Water supply wells, tanks, and pumps associated with 1,455 transient non-community water systems
- Approximately 322,500 private water supply wells
- Approximately 80 major power generation and cogeneration facilities and their associated cooling and/or process water systems
- Hundreds of river and stream intakes, ponds, and wells used by farms, nurseries, golf courses, sand and gravel extraction/washing facilities, and other industries
- Several flood control dams
- Several levee and dike systems

Stormwater infrastructure in Connecticut includes:

- Municipal stormwater collection, conveyance, and discharge systems
- Private stormwater collection, conveyance, detention/retention, and discharge systems
- A few remaining combined sewer systems in six municipalities

Wastewater infrastructure in Connecticut includes:

- Sanitary sewer systems
- Publicly-owned treatment works (POTWs), often known as wastewater treatment plants, sewage treatment plants, and/or water pollution control facilities
- Private wastewater treatment facilities
- Two reclaimed water facilities
- A comparatively small but not insubstantial number of alternative treatment systems
- Hundreds of large, regulated subsurface sewage disposal systems
- Thousands of private septic systems

A final class of water infrastructure is fire protection/suppression facilities. These may include traditional hydrants, dry hydrants, fire ponds, cisterns, etc.

For ease of discussion, the remainder of this section will discuss water supply infrastructure for public water supply, fire protection, water supply infrastructure for other water uses, stormwater infrastructure, and wastewater infrastructure.

2.1.6.1 Public Water Supply Infrastructure Capacities

Public water systems vary drastically within the State of Connecticut, both in service area, system capacities, and supply source availability. Systems also vary in the ability to provide fire protection, emergency storage, and emergency power operation, among other factors. Infrastructure capacities are summarized in this Section, with references to a number of tables that provide information on community water systems, municipalities and other suppliers. These tables are numbered and titled as follows, and are attached to the report as Appendix D:

Table 2-5: Major Facilities of Community Water Systems Serving >1,000 People

Table 2-6: System Demand, Available Yield, and Margin of Safety for Water Systems Serving >1,000 People

Table 2-7: Summary of System Reliability Characteristics for Community Water Systems Serving > 1,000 People

Table 2-8: List of Active Interconnections

Table 2-9: Planned and/or Identified Future Interconnections

Table 2-10: Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Table 2-11: Potential Future Source of Supply Exploration Planned/Needed for Community Water Systems Serving > 1,000 People

Table 2-12: Firefighting Capabilities by Municipality

General Public Water System Capabilities

Tables 2-5 and **2-6** list systems, organized by municipalities served, and the available capabilities of each system. The presence or absence of groundwater supplies, surface water supplies, treatment, distribution pumping, and storage, is noted in the table. Although these classifications do not indicate a system's reliability, they do indicate system flexibility. A system with a variety of capabilities may have an increased ability to provide services such as fire protection and emergency storage. Additionally, a utility that has diversified its supply between surface and groundwater sources could react more favorably to stressful hydrologic conditions that a system relying on one source type.

Supply and Distribution Capacities

Under DPH Guidelines for individual water supply plan development (systems serving >1,000 people), it is the responsibility of the water utility to demonstrate that it has an adequate margin of safety of available water in excess of demand. Per Regulations of Connecticut State Agencies (RCSA) Section 25-32d-1a(a)(22), margin of safety is the unit less ratio of available water to demand. It is system specific and is based only on available active supplies, considering hydraulic, permitting, or other supply limitations.

A margin of safety of at least 15% (1.15) relative to a 99% (critical dry period) safe yield is recommended by PURA [RCSA 16-262m-8(d)(1)], but the 15% recommendation is typically used for planning purposes on the basis of available water as required by DPH. Margin of safety is required to be evaluated for average day, maximum month average day, and peak day demand

conditions using the same value for available water, but margin of safety is typically evaluated for maximum month average day and maximum day conditions using higher values of available water based on historical DPH guidance. Certain systems may have an adequate average day margin of safety, but experience peak demand deficiencies. Other systems can meet peak requirements but have marginal or inadequate supplies to sustain long-term average day demands.

Table 2-6 shows the demand, available water, margin of safety, and other critical system information of community systems serving more than 1,000 people. The available data indicates that most of the larger systems are meeting average day demands with a 15% or more margin of safety.

System capacity hinges on a systems ability to supply water under adverse conditions such as power outages, system component failure, or failure of a supply source. **Table 2-7** shows the availability of backup supply, emergency power, and interconnections. The presence, or absence of these factors does not indicate a particular system's reliability, but, it may indicate an increased ability to meet service requirements under adverse conditions.

Systems serving greater than 1,000 people are required to have an asset management program for tracking infrastructure age and condition. Water utilities routinely replace water mains depending on available operating and capital improvement budgets, and there are so many replacements ongoing at any time that it would be difficult to list them all. However, many water utilities are replacing water mains at a pace that is less than ideal, and often need to address ageing infrastructure as water mains break. Many smaller systems have no such asset management program, and in some cases can be caught off-guard by the costs necessary to design and construct improvements.

2.1.6.2 Interconnections

Interconnections help water utilities better prepare for adverse conditions by diversifying the type of water supply (surface vs groundwater) and increasing spatial distribution of the supply. Interconnections can also help accommodate the surge in demand that occurs during firefighting. Additionally, some interconnections provide a means of interbasin transfer, which can re-allocate water from less stressed to more stressed basins in time of shortage. **Table 2-8** indicates all active interconnections in the state between public water systems. As is evident from the table, some utilities readily take advantage of interconnections, while others have historically used them sparingly, if at all.

Many CWS have identified future potential interconnections, either to promote source redundancy or to meet future supply needs. Interconnections have been proposed and constructed for a number of uses, including emergency supply, to increase redundancy, supplementing existing supply, the selling off of excess water, or planning for a future demand increase.

In the state, there are approximately 60 planned or identified potential interconnections for additional supply in large community systems alone. This indicates that a substantial number of utilities have incorporated the need for interconnections into their planning periods. **Table 2-9** shows planned/identified future interconnections.

2.1.6.3 Future Treatment Plants and other Infrastructure Improvements

While it can be expected that all utilities will perform minor maintenance on their infrastructure within a typical planning period, some utilities have enacted major improvements. For example, the Connecticut Water Company Western System's Rockville Treatment Plant is in the process of expanding, consistent with its approved Water Supply Plan, which helps to accommodate the increasing demand over the near term. Common infrastructure improvements include treatment plant upgrades, dam modifications/alterations, distribution system maintenance and upgrades, and increases in storage and system pressure. **Table 2-10** shows the planned or identified system alterations for large systems.

Future Sources of Supply

There are several large and small community water systems that are exploring the creation of new sources, or the reactivation of existing sources. Although no new reservoirs are currently proposed in Connecticut, many new or replacement wells are being considered within the near future. In all, nearly 80 large community systems are described as planning for, or needing additional supply in the short to medium-term. **Table 2-11** indicates which systems may explore an increase in supply in the 5-year planning period, and beyond.

Firefighting Capacities

There are no regulatory requirements for a public water system to maintain firefighting capabilities. Individual requirements for fire protection are addressed indirectly in the application process for a Certificate of Public Convenience and Necessity (Section 16-262m-5(e) of the Regulations of Connecticut State Agencies) for small water companies which are regulated by PURA in coordination with DPH. A letter from the town where the project is located must be submitted with the application to PURA, indicating whether or not fire protection facilities are required to be included in the design of the water system. The PURA regulations also state that fire protection is not allowed to be provided via hydrants unless the system has more than 150,000 gallons in storage. However, there is no explicit requirement imposed by PURA to provide fire protection.

Table 2-12 shows the firefighting capabilities by municipality, broken out by water utility. The majority of larger systems have adequate pressure and system components to provide some form of fire protection to customers within their supply area, however the quantity of hydrants provided by each system vary dramatically. Most of the smaller CWS provide little or no fire protection, as it is unlikely they maintain the necessary minimum storage volume limit imposed by PURA.

Table 2-5 also provides information on firefighting capacity, as it indicates if systems have storage, and distribution pumping abilities. A system with both of these capabilities is more likely to be able to meet the sudden surge in demand that firefighting requires, as well as ensuring that pressure is adequate throughout the service area.

The state's municipalities have a number of methods of planning for and promoting the development of new fire protection facilities. Most of the rural communities require dry hydrants, cisterns, etc., in connection with new developments. Suburban and urban communities rely on extensions of public water systems with fire hydrants.

2.1.6.4 Water Supply for Other Water Uses

Water infrastructure for other water uses is difficult to catalogue. As noted above, approximately 80 major power generation and co-generation facilities are located in Connecticut. All are assumed to rely on associated cooling and/or process water systems, but not all 80 are operating their own water supplies. Many are customers of public water systems.

Based on lists of registered and permitted diversions, one can estimate that there are hundreds of river and stream intakes, ponds, and wells used by farms, nurseries, golf courses, sand and gravel extraction/washing facilities, landscaping businesses, and other industries in Connecticut. An inventory may be generated by reviewing lists of registered and permitted diversions, but this methodology would omit the hundreds of facilities that fall below the diversion threshold of 50,000 gallons per day. Consider the following:

- Approximately 160 sand and gravel excavation and washing facilities are located in Connecticut, and most of them utilize their own water sources (if water is used)
- Approximately 180 golf courses are located in Connecticut, and most of them utilize their own water sources, although a few purchase water from public water systems
- The number of agricultural water users is unknown. While many farms use water for irrigation, many do not.
- At least 230 nurseries are located in Connecticut - likely many more than that - but many are small garden centers that purchase water from public water systems.

Due to the diversity of water users, the infrastructure cannot be characterized. Nevertheless, it is likely that many users are upgrading or replacing infrastructure. For example, many private and public golf courses have replaced irrigation systems in the past 15-20 years, allowing more efficient watering of turf. Many nurseries are replacing spray irrigation systems with drip irrigation systems. Many sand and gravel producers are installing ponds and tanks to enable recycling of wash water, cutting the need for fresh makeup water. It is likely that many of these infrastructure improvements will continue in Connecticut.

2.1.6.5 Stormwater Infrastructure

The condition and performance of stormwater infrastructure in Connecticut is a topic of great interest. In general, stormwater infrastructure is managed or regulated by hundreds of sets of ordinances and regulations administered by the state's municipalities. Towns and cities maintain different schedules and budgets for catch basin cleaning, have different design criteria for collection and conveyance systems, and sometimes have different opinions about how to discharge stormwater (for example, rapid discharge to watercourses vs. detention or retention). Municipalities are currently addressing changes associated with the Municipal Separate Storm Sewer Systems (MS4).

Many of the state's municipalities are planning for maintenance, upgrades, and/or replacements to parts of their stormwater systems. Stormwater system and drainage system projects are routinely included in municipal capital improvement plans. At the same time, many municipalities are interested in LID (low-impact development) techniques and are promoting or requiring LID to reduce the need for costly stormwater system upgrades.

Six municipalities in Connecticut have a few remaining sections of combined sewer systems that can lead to overflow and discharge of untreated sewage. Elimination of these systems and replacement with separate sewer systems is a very high priority in Connecticut.

2.1.6.6 Wastewater Infrastructure

Many of the sewage treatment plants in Connecticut have been operating for 50 or more years and are faced with a number of significant upgrades in the coming years. These upgrades are generally necessary for further water quality improvements (for example, nitrogen and phosphorus reduction). However, because most of the sewage treatment plants are located at low elevations near watercourses or Long Island Sound, many of the facilities are also finding it necessary to make improvements for flood and storm resiliency. Some facilities, such as those in Groton and Stonington, were able to incorporate resiliency measures into capital improvement projects that also improved wastewater treatment.

2.2 Current Policy Assessment

Two white papers were prepared to identify and discuss current water management and land management practices in Connecticut. These papers are not intended to convey positions, priorities, values, or recommendations. Rather, they are factual documents reviewed by the four entities with purview over water: DEEP, DPH, OPM, and PURA, as well as the Water Planning Council and its supporting subcommittees and advisory groups.

The papers are introduced briefly below, and then included in their entirety in the subsequent two sections. Two additional white papers on future considerations (water management options and future challenges) are discussed and presented in **Section 3.2**.

The first paper is titled "**Understanding Connecticut's Water Resources Management Structure**," and is included as Section 2.2.1. It focuses on three themes: 1) The roles and responsibilities of the four state entities who collectively manage and regulate water in Connecticut (DEEP, DPH, OPM, and PURA), as well as areas of overlap in their responsibilities, 2) The structure of the Water Planning Council and its supporting committees and work groups, all of whom are tasked with orchestrating the development of the State Water Plan, and 3) Current water management programs in the state and the organizations responsible for their oversight. Included in this paper are overviews of programs and regulatory responsibilities for:

- Water supply (individual water supply plans, WUCCs, Source Water Assessment Program, Safe Drinking Water Act, watershed protection, private drinking water wells)
- Water diversion
- Water quality standards
- Wastewater
- Stormwater and other non-point pollution sources, and aquifer protection
- Inland wetlands
- Coastal management
- Drought management

- Streamflow
- Recreational waters
- Fisheries management
- Ecological health of river systems
- Comprehensive state energy strategy
- Related state, regional, and local plans of conservation and development
- Funding and financing

Like many states, Connecticut relies on more than one agency to regulate water. One of the key themes of this paper is that the current regulatory framework for water management includes certain roles that may not always function toward the same objectives. For example, DEEP is responsible for instream flow provisions, but these can pose certain challenges to water supply and public health, which are regulated by DPH and PURA. The paper also provides an overview of the Water Planning Council and its various supporting committees, establishing a framework to evaluate how this structure can be most effective during future implementation phases of the Plan.

Again, the full white paper on the state's current water management structure is included as Section 2.2.1 of this report.

The second white paper in this section is entitled "**Land Conservation and Economic Development Plans.**" It is included as Section 2.2.2 of this report. It outlines land management practices and how they relate to water policies, watershed protection, aquifer protection, etc. While land management is often governed locally, the State Water Plan necessarily evaluates patterns and management strategies at a regional level, so the paper focuses on general examination of land management trends at regional and statewide scales. It also discusses trends in land development in the eastern, central, and western regions of the state. Ultimately, water and land management policies are intrinsically linked in Connecticut: some water management policies and programs affect land management, and some land management policies and programs affect water management.

At the local level, Chapter 126, Section 8-23 of the Connecticut General Statutes requires that municipal planning commissions "prepare, adopt and amend a plan of conservation and development for the municipality" (POCD) once every ten years. Among many things that the POCD should include, it shall consider protection of existing and potential public surface and ground drinking water supplies. Municipalities are enabled to plan for economic development as part of the POCD insofar as the fact that POCDs must address areas for commercial development, infrastructure, etc. Municipalities are not required to develop stand-alone economic development plans, but many choose to do so.

At the regional level, Connecticut's planning regions provide a geographic framework within which municipalities can jointly address common interests, and coordinate such interests with state plans and programs. Among these plans is the Regional Plan of Conservation and Development, which provides recommendations involving land use, housing, parks, recreational

areas, and other matters of regional importance. The regional plans not only provide a regional vision for conservation and development, but also serve as the basis for the Councils of Government (COGs) to fulfill their roles of commenting on the consistency of municipal Plans of Conservation and Development with regional and state-level plans and growth management principles.

At the state level, the Conservation and Development Policies Plan is developed and updated on a five-year revision cycle by the Office of Policy and Management and adopted by Connecticut's General Assembly under the provisions of Chapter 297, Section 16a-24 to 16a-33 of the Connecticut General Statutes. The current Plan was adopted by the Connecticut General Assembly on June 5, 2013, and includes six Growth Management Principles that lay out major priorities for guiding conservation and development across the state, as well as policy statements that provide a basis for state agencies to assess the consistency of their proposed plans and actions with the State Plan:

1. Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure.
2. Expand Housing Opportunities and Design Choices to Accommodate a Variety of Household Types and Needs.
3. Concentrate Development around Transportation Nodes and Along Major Transportation Corridors to Support the Viability of Transportation Options.
4. Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands.
5. Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety.
6. Promote Integrated Planning Across all Levels of Government to Address Issues on a Statewide, Regional and Local Basis.

Again, the full white paper on Land Conservation and Economic Development Plans is included as Section 2.2.2 of this report.

2.2.1 Understanding Connecticut's Water Resources Management Structure

This white paper includes a summary of current water resource management structure topics, and is incorporated into the State Water Plan. This white paper describes the existing management structure at the state, regional, and local levels (including roles and responsibilities of agencies and committees), and identifies significant components of the decision-making process. The paper provides an overview of current water and land management strategies and regulatory programs, including but not limited to, water supply (individual water supply plans, WUCCs, Source Water Assessment Program, Safe Drinking Water Act, watershed protection, private drinking water wells); water diversion; water quality standards; wastewater (individual municipal facilities plans, Clean Water Act, Water Pollution Control Authorities); stormwater and other non-point pollution sources; aquifer protection; inland wetlands; coastal management; drought management; stream flow; recreational waters; fisheries management; comprehensive state energy strategy, related state, regional, and local plans of conservation and development; and funding and financing.

In the Plan, the term "balance" is used to remind decision makers to consider social, environmental, and economic factors of all uses, and to ensure that all aspects of planning and decision making are data-driven to the practical extent possible. As with so many components of the Plan, the use of the word "balance" needs to be taken as part of the overall Plan, not necessarily specific to one component, and that "balance" considered during future water management decisions needs to be topic-specific. A current water resource management structure topic that was brought up during the Plan's public comment period, which the WPC considers related to balance, is water as a public trust. Note the DEEP statute as part of Chapter 439 as follows: Sec. 22a-15 Declaration of policy. It is hereby found and declared that there is a public trust in the air, water and other natural resources of the state of Connecticut and that each person is entitled to the protection, preservation and enhancement of the same. It is further found and declared that it is in the public interest to provide all persons with an adequate remedy to protect the air, water and other natural resources from unreasonable pollution, impairment or destruction.

WP1-1. Organizations and Regulatory Management Authority[6]

Connecticut has traditionally managed its water through four regulatory agencies with separate, and sometimes conflicting, legislative mandates and authorities. They include the Office of Policy Management (OPM), The Department of Energy and Environmental Protection[7] (DEEP), The Department of Public Health (DPH), and the Public Utilities Regulatory Authority (PURA), formerly known as DPUC.

[6] Source: CT State Water Plan RFQ pg 25

[7] Public Act 11-80, "An Act Concerning the Establishment of the Department of Energy and Environmental Protection and Planning for Connecticut's Energy Future" combined the former Department of Public Utility Control (DPUC) and an energy group from the Office of Policy Management (OPM) with the Department of Environmental Protection (DEP) to form the Department of Energy and Environmental Protection (DEEP) to better address the challenges of the modern environmental world and energy market. The former Department of Public Utility Control is now called the Public Utility Regulatory Authority (PURA) and continues to perform the regulatory functions of the former DPUC. The Act also required DEEP establish a Bureau of Energy and Technology Policy – the first energy policy office in decades for the state.

- **Department of Public Health (DPH)** is responsible for protecting and regulating the quality and quantity of the state's drinking water by regulating adequacy and purity of all public water systems in the state, including the ownership and use of water utility-owned lands, under its Drinking Water Section. DPH has been granted primacy by EPA and has many regulatory duties under the Safe Drinking Water Act and the Connecticut Public Health Code, but also possesses key state statutory authority in the direct oversight of public water systems and planning authority relative to individual water supply plans and coordinated water system plans as well as source water protection. DPH has the statutory authority to develop regulations for private residential wells and semi-public use wells. DPH also has a role in the distribution of funds under the Drinking Water State Revolving Fund. DPH oversees over 95% of all onsite wastewater treatment systems in Connecticut, , but DEEP oversees the largest of these as described later in this paper.

- **Department of Energy and Environmental Protection (DEEP)** is responsible for the protection of the state's natural resources, which include inland and coastal waters. DEEP manages water quality and quantity through numerous programs such as the Water Quality Standards. Like DPH, DEEP possesses regulatory, planning, enforcement, and funding authorities. Regulatory programs address water quantity and water quality, including many of the programs described in this paper. Planning programs address mainly water quality (for example, overseeing watershed management plans) rather than water quantity which has typically been managed through regulatory programs. DEEP funding program examples include the Clean Water State Revolving Fund (CWSRF), the Potable Water Program, and the Section 319 grants for impaired waters, among many others.

- **Public Utilities Regulatory Authority (PURA)** regulates the rates and services of Connecticut's investor-owned water companies and is part of the Energy Branch of DEEP. PURA directly regulates the investor-owned water and wastewater utilities in Connecticut, and formerly participated in the review and approval of new public water systems (with DPH). PURA regulates other utilities that have a bearing on water (for example, electricity generation)

- **Office of Policy and Management (OPM)** prepares periodic revisions to the Conservation and Development Policies Plan for Connecticut and oversees various planning and environmental review processes that address water. OPM plays a key role in the approval of Environmental Impact Evaluations prepared under the Connecticut Environmental Policy Act, ensuring that state actions are consistent with the Conservation and Development Policies Plan for Connecticut as well as other planning documents. OPM is also a key agency relative to oversight of various funds that affect water. According to Stream Flow[8] (December 2003), OPM has general responsibility to coordinate all activities of DEP, DPH, and DPUC with respect to the state's water resources policies.

[8] https://www.cga.ct.gov/2003/pridata/Studies/PDF/Stream_Flow_Final_Report.PDF

WP1-2. Connecticut's Water Planning Council

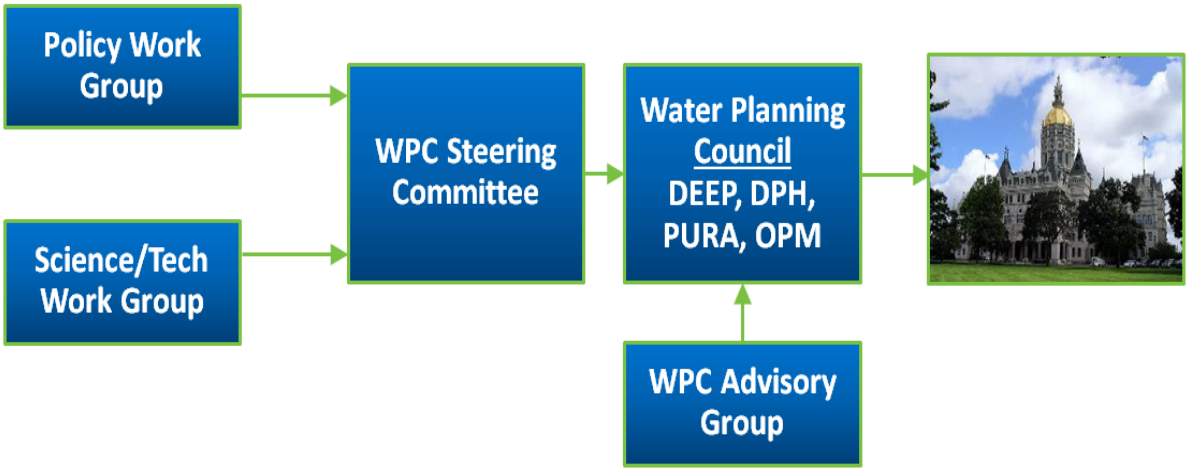
The Connecticut Water Planning Council was created by the Energy and Technology Committee of the Connecticut General Assembly in 2001 with representation from the four state agencies described above (DPH, OPM, and the predecessors of DEEP and PURA [DEP and DPUC]). The charge of the WPC is to "identify issues and strategies which bridge the gap between the water supply planning process and water resources management in order that water can be appropriately allocated to balance competing needs while protecting the health, safety and welfare of the people of Connecticut and minimizing adverse economic and environmental effects."[9] The WPC does not receive regular, dedicated funding from the state.

The WPC initially established three Committees to investigate specific issues identified in PA 01-177 and submitted an Issues Work Plan to the Legislature on January 28, 2002. The three committees were the Water Resource Management Committee, the Water Utility Committee, and the Technical Management Committee. Each committee supervised the work of two subcommittees that, together, evaluated 11 issues ranging from review of water rates to streamlining the diversion permit process. A full description of this process can be found in other reports. Since that time, the WPC has overseen progress in promoting policy and regulations for management of the state's water resources.

The WPC established the Water Planning Council Advisory Group (WPCAG) pursuant to PA 07-4, Section 2(c) in 2007 to assist in researching and analyzing water resources issues. The WPCAG has formed a number of work groups over the years. The WPCAG typically oversees the work completed by its work groups and reports back to the WPC about specific issues.

In 2015, the WPC formed a Steering Committee with representatives from the WPC and the WPCAG to work with the parties providing services during the development of the State Water Plan. The WPC Steering Committee is therefore directly associated with the State Water Plan and is charged with assisting the WPC with development of the State Water Plan. While the WPCAG envisioned a small committee to provide timely feedback to the consultant in the process between WPC meetings, the Steering Committee ultimately was much more expansive, including all of those individuals on the WPC.

[9] DEEP, http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325644&depNav_GID=1654



Several subcommittees have helped the WPC with development of the State Water Plan. The "Other States' Plans" work group operated from 2015 through early 2016 (as a work ground of the WPCAG), and reviewed the water plans produced by other states. This work group also prepared a model table of contents for the State Water Plan. The group is now not operating, as its work has been completed. The Policy Subcommittee and Technical/Science Subcommittee were two subcommittees of the Steering Committee contributing to development of the State Water Plan. These subcommittees are no longer active.

WP1-3. Public Water System Planning[10]

WP1-3.1. Individual Water Supply Planning

Connecticut's public water supply planning process was prompted by the state's extended drought in the early 1980s and was an outcome of a water resources task force

In the State of Connecticut, all water companies serving greater than 1,000 people are required to develop and maintain a water supply plan. Plans are developed in accordance with Section 25- 32d-1 of the Connecticut General Statutes and Section 25- 32d of the Regulations of Connecticut State Agencies, and are typically updated every six to nine years. These regulations and the supporting statutes recognize that planning is a critical management activity of all water utilities. The principal goals of water system planning as defined by the Connecticut DPH are to: (1) ensure an adequate quantity of pure drinking water, now and in the future; (2) ensure orderly growth of the system; and (3) make efficient use of available resources. PURA, OPM, and DEEP all provide review comment to DPH in the agency's review of water supply plans.

[10] Water Supply Plans- Milone & MacBroom

All water supply plans begin with a description of the water utility's structure and assets. This section normally includes information on company structure, employee certifications, company finances, and assets. The next sections typically provide a description of water supply sources, supply capacity, system performance, and water quality. These sections often provide source safe yield and available water, as well as distribution system specifications, and water quality records.

After describing company infrastructure and available output, the water supply plans generally focus on present and future water demands, service area land use, and source protection. These sections often observe trends within current demographics and attempt to extrapolate them into the future, to anticipate any improvements and changes that will need to be made to company infrastructure. Water supply plans help ensure that water utilities are able to adjust to changing human populations and environmental conditions within the supply area and are planning to meet projected demand over a 50-year period.

Connecticut is somewhat unusual in the fact that its public water systems include private, regional, and municipal water providers. The uniqueness includes the sheer number of separate public water systems and the potential for continued growth of small systems, along with the varying types of financial oversight. Many stakeholders have noted that this poses certain challenges to the uniformity with which regulations are applied, planning is accomplished, and policies are adopted. It will be important for the WPC to consider these differences, some of which are subtle, during the implementation of the Plan recommendations.

WP1-3.2. Coordinated Water System Planning[11]

As noted above, Connecticut's public water supply planning process was prompted by the state's extended drought in the early 1980s. During the 1985 Legislative Session, the Connecticut General Assembly passed Public Act 85-535, "An Act Concerning a Connecticut Plan for Public Water Supply Coordination," initiating the first statewide water supply planning program. The Connecticut DPH in consultation with the former DPUC (now PURA), DEEP, and OPM was given the charge of developing a coordinated approach to long-range water supply planning to assure adequate future supplies. The legislative finding, as reflected in Section 25-33c of the CGS, states the following: "In order to maximize efficient and effective development of the state's public water supply systems and to promote public health, safety, and welfare, the DPH shall administer a procedure to coordinate the planning of public water supply systems."

Pursuant to Public Act 85-535 and Section 25-33e of the CGS, the boundaries of seven public water supply management areas (PWSMAs) were delineated based upon the similarity of water supply issues, population density and distribution, existing sources of public water supply, service areas or franchise areas, existing interconnections between public water systems, municipal and regional planning agency boundaries, natural drainage basins, and similar topographic and geologic characteristics.

The CGS required that the Commissioner of DPH convene a Water Utility Coordinating Committee (WUCC) for each PWSMA to implement the area wide water supply planning process. A WUCC is open to membership consisting of one representative from each public water system with a

[11] Coordinated Water System Plan- Scott Bighinatti

source of water supply or service area within the PWSMA, and one representative from each regional planning agency within such area who is elected by majority vote of the chief elected officials of the municipalities that are members of such regional planning agency.

Four of the seven WUCCs were convened under the previous planning process, as outlined below:

- The Housatonic Area WUCC convened in June 1986;
- The Upper Connecticut River Area WUCC convened in March 1987;
- The South Central Area WUCC convened in November 1987;
- The Southeastern Area WUCC convened in August 1998; and
- The Northeast Area WUCC, Northwest Hills Area WUCC, and Southwest Area WUCC never convened.

A "Coordinated Water System Plan" is comprised of the individual water supply plans of the public water systems within the PWSMA which serve over 1,000 people or have 250 or more service connections, and an "area wide supplement" which includes a water supply assessment, delineation of exclusive service area boundaries, an integrated report, and an executive summary. Each of the four WUCCs that convened produced such documents, but only the Southeastern Area WUCC coordinated plan was formally approved by DPH.

DPH began considering consolidation of the PWSMAs and reconvening the WUCCs in 2009. Based on the needs identified by DPH and other stakeholders, the number of PWSMAs was consolidated from seven to three in October 2014. Each PWSMA boundary is consistent with the recently realigned regional planning agency boundaries completed by OPM. The WUCC representing each PWSMA convened in June 2016 with the goal of developing new coordinated water system plans over the two-year process from June 2016 through June 2018. The individual components of the area wide supplement (listed above) will be subject to state agency consultation and public review and comment, as required.

WP1-3.3. Certificate of Public Convenience and Necessity

The Certificate of Public Convenience and Necessity (CPCN) is a process for establishing new public water systems. Although the individual water supply planning and coordinated water system planning (described above) are somewhat unique to Connecticut, the CPCN is similar to other states' staged or stepped processes for approving new water systems. PURA and DPH manage the process in three phases. Phase IA is commonly known as the new source site approval, but it includes an overall review of the project's location and general characteristics. Phase IB includes a review of new source quantity and quality. Phase II is the review and approval of detailed plans for the new water system.

By statute, the CPCN is designed to work with the coordinated water system planning process. A convened WUCC may review and approve of new public water systems in a PWSMA while the CPCN process is underway, providing feedback to DPH during its review steps within the CPCN. However, WUCC approval is not necessary if a nearby water system is unable to serve an area targeted for creation of a new public water system.

In the last few years, PURA has scaled back its review of CPCN applications for non-community systems, focusing on the community systems that are proposed. As of 2016, DPH fully manages the CPCN process and involves PURA as needed for all public water system applications.

WP1-4. Private Well Management

WP1-4.1. Private Well Program

According to the DPH, approximately 322,578 private residential wells in Connecticut serve approximately 23% of the state's population.

Private wells that supply residential properties for domestic use and many small non-residential properties are not regulated by the EPA, and likewise are not regulated by the DPH's Drinking Water Section. Private well owners are responsible for testing the quality of their own drinking water and maintaining their own wells. Private wells are initially tested when a well is first constructed for basic parameters and may not be tested for several years thereafter. Private wells are typically tested during the home inspection of a real estate transaction or when required by a mortgage company. Testing of private wells since 2013 for metals such as arsenic and uranium that were not likely included in the basic testing of a private well prior to this timeframe has resulted in the identification of areas of the state with very high levels of these naturally occurring contaminants.

Well yield and well construction data is not available in one location, but can be found on thousands of drillers' logs filed with the Department of Consumer Protection.

The state's 73 local health departments and districts have the authority over all private wells in the towns where they have jurisdiction, and all municipalities are served by either a municipal health department or a health district. Private wells must be properly sited, tested, and the water quality results approved by the local director of health before a certificate of occupancy is granted. DPH maintains a Private Well Program that provides outreach and education to the public, technical guidance, and training to local health departments and districts. DPH has the statutory authority to develop regulations for private residential wells and semi-public use wells[12] (discussed below).

[12] CGS 19a-37, Public Act 16-66, Section 20

WP1-4.2. Semi-Public Wells

Semi-public wells serve less than the 25-person minimum to be classified as a public water system, yet serve more than a single residence or building. These systems fall into somewhat of a regulatory loophole, as they are exempt from the reporting and regulations required by a public water supply system. Instead, they are regulated just as private wells, with oversight by the state's 73 local health departments and districts. This presents a challenge to DPH, as their oversight is limited, yet adverse water quality or well construction conditions can affect a large number of people. Public Act 16-66 established authority under Connecticut General Statutes Section 19a-37 for the Commissioner of Public Health to adopt regulations for the testing of water quality on semi-public use wells.

WP1-5. Safe Drinking Water Act[13]

The Federal Safe Drinking Water Act (SDWA) was passed in 1974. The act authorized the federal government to set national drinking water standards, conduct special studies, and to generally oversee the implementation of the act. However, primary responsibility of implementation and enforcement essentially remained in the hands of state government.

Prior to 1974, the responsibility for regulation of public drinking water supplies rested on state government.

Subsequent to the passage of the SDWA, interim primary drinking water regulations were promulgated. These regulations and subsequent revisions set standards for organic, inorganic, and microbiological contaminants; turbidity; radionuclides; and trihalomethanes (THMs).

In June 1986, amendments to the SDWA were adopted. The amendments converted interim and revised primary drinking water standards to national primary drinking water regulations and converted recommended maximum contaminant levels (RMCLs) to maximum contaminant level (MCL) goals.

Since the adoption of the 1986 amendments, EPA has been working toward promulgating national primary drinking water regulations for various parameters. On July 8, 1987, EPA published regulations setting MCLs and MCL goals for eight volatile organic compounds and monitoring for a number of additional volatile organic compounds without MCLs. These regulations became effective January 9, 1989. In May 1989, EPA proposed national primary drinking water regulations for 38 additional inorganic and organic drinking water contaminants.

On January 30, 1991 (effective date July 30, 1992), EPA promulgated MCLs for a series of parameters referenced as the "Phase II" compounds, which include nine inorganic compounds, 10 volatile organic compounds, and 15 synthetic organic compounds. Monitoring requirements were specified for an additional 24 synthetic organic compounds without MCLs.

On June 7, 1991, the U.S. EPA promulgated maximum contaminant goals and National Primary Drinking Water Regulations for controlling lead and copper. These action levels were adopted pursuant to the Lead Contamination Act of 1988. The regulations specify a treatment technique

[13] https://www.epa.gov/sites/production/files/2015-04/documents/epa816f04030.pdf

that includes optimal corrosion control treatment, source water treatment, lead service line/connection replacement, and public education.

Beginning on July 1, 1992, any public water system that served greater than 3,300 and less than or equal to 50,000 persons was required to conduct initial tap water monitoring for lead and copper at targeted sampling sites. Any medium-size water system that exceeded the lead or copper action level was required to monitor applicable water quality parameters at additional taps in the distribution system and at each entry point to the distribution system. Additionally, any water system that subsequently failed to meet the lead or copper action level was required to collect one source water sample from each entry point to the distribution system within six months after the exceedance. However, lead monitoring protocols are changing rapidly and the CT DPH plans to work closely with EPA to modify methods used by public water systems in Connecticut.

On July 17, 1992 (effective date January 17, 1994), EPA promulgated the "Phase V" compounds, including five inorganic compounds and three volatile organic compounds with MCLs, and 21 volatile organic compounds and 15 synthetic organic compounds without MCLs.

The SDWA was reauthorized in 1996. The law focuses water program spending on the contaminants that pose the greatest risk to human health and that are most likely to occur in a given water system. It also requires water systems to notify the public of water safety violations within 24 hours. It maintains requirements that EPA set both a maximum contaminant level and a maximum contaminant level goal for regulated contaminants based on health risk reduction analysis that includes a cost/benefit consideration. The revised act also requires EPA to establish a database to monitor the presence of unregulated contaminants in water.

At the state level, the authority for regulation of public drinking water is established under Section 25-32 of the Connecticut General Statutes (25-32 provided the State Health Department oversight of water companies since the early 1900s) and implemented through the PHC by DPH. These requirements are consistent with federal regulations and have additional requirements such as annual watershed surveys, annual cross connection surveys, monitoring of raw and finished water, and public notification requirements.

In 1991, the state DPH adopted regulations and criteria pursuant to the EPA Surface Water Treatment Rule to evaluate all community groundwater sources by June 29, 1994 to determine if the sources were under the direct influence of surface water.

In December 1998, EPA published the Stage 1 Disinfectants/Disinfection Byproducts Rule (DBPR). This rule requires water suppliers to use treatment methods to reduce the formation of disinfection byproducts and to meet associated water quality standards. The disinfection byproducts and their corresponding standards include the total trihalomethanes (TTHM) and the total haloacetic acids (THAA). The TTHM is measured as the total concentration of chloroform, bromoform, bromodichloromethane, and dibromochloromethane. The EPA standard for TTHM concentration is 80 parts per billion (ppb). The THAA is measured as the total concentration of monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. The EPA standard for THAA is 60 ppb. Both disinfection byproduct standards are based on annual averages.

The Stage 2 DBPR was published by EPA in January 2006. The purpose for the second stage was to improve public health protection by reducing health risks connected to large concentrations of disinfection byproducts throughout the entire supply system. The Stage 2 DBPR emphasizes the monitoring and reduction of concentrations of TTHM and THAA at sampling locations throughout the distribution system. The monitoring frequency and sampling locations are dependent upon the population size that the distribution serves.

WP1-6. Source Water Protection[14]

WP1-6.1. Source Water Assessment Program

The Source Water Assessment Program (SWAP) was part of the 1996 amendments to the federal Safe Drinking Water Act, which are described above. The program called for the nationwide assessment of all public drinking water supply sources to determine their susceptibility to potential sources of contamination. The goal of Connecticut's SWAP as administered by DPH was to identify and inventory potential sources of contamination that could adversely impact the safety or quality of Connecticut's public drinking water sources, including more than 150 surface water reservoirs and more than 4,000 groundwater supply wells that provide drinking water for about 77% of the state's population.

DPH completed the assessment of more than 3,800 community and noncommunity public drinking water sources on April 29, 2003, working with DEEP in the process. The assessment method used by DPH included a determination of susceptibility for the following three categories: (1) environmental sensitivity, (2) potential risk factors, and (3) source protection needs. Based on source-specific information, each system of water supplies (a reservoir, reservoir system, or well system) was given a low, moderate, or high rating for each of the three categories. The assessment process consists of five main elements:

- Delineation of source water areas for each public drinking water source. The source water area for a well is more difficult to delineate. Large community wells in stratified drift are subject to Aquifer Protection Program regulations in sections 22a-354a through 22a-354bb of the Connecticut General Statutes. Preliminary (Level B) or Final (Level A) Aquifer Protection Area mapping where data are available for stratified drift wells is an example of source water delineation. For bedrock wells a calculated radius proportional to the pumping rate of the well, is used to delineate the source water area.
- Inventory of potential contaminant sources (SPCS) within the source water areas of each public water supply source.
- Susceptibility to inventoried potential contaminant sources for all community public drinking water source based on three key indicators: (i) Source Sensitivity: Water Quality, Source Integrity and Condition (ii) Source Vulnerability: Existence of Potential Pollution Sources, Land Use/Cover (iii) Source Protection: Land Control, Water Company Measures, and Local Protection Measures. The overall susceptibility of each community drinking water source is determined using the factors associated with indicators i through iii. Initial assessments of non-community drinking water sources are based on sensitivity and

[14] http://www.ct.gov/dph/lib/dph/drinking_water/pdf/SWAPWEB_05_12.pdf

vulnerability while more information is gathered about source protection needs for these types of systems.

- Public participation in SWAP using a committee of stakeholders.
- Availability of source water assessments to the general public with recommendations for protection.

The SWAP's intended purpose was a one-time barometer of source protection needs in Connecticut. Due to changes to 25-32d-1, similar source protection provisions have been incorporated under water supply planning. Other regulatory programs such as the water supply planning process and the Aquifer Protection Program (described below) have continued to make strides in source protection.

At the state level, DPH has been responsible for public drinking water regulation and oversight since the early 1900s, significantly preceding the SDWA.

WP1-6.2. Public Water Supply Watershed Protection

The authority for regulation of drinking water is established under Section 25-32 of the Connecticut General Statutes and implemented through the Regulations of the Connecticut State Agencies (RCSA) and the Public Health Code (PHC). These requirements are consistent with the federal regulations that oftentimes came later, but have additional requirements such as annual watershed surveys, annual cross connection surveys, monitoring of raw and finished water, and public notification requirements.

Several very early public health laws in Connecticut recognized the link between disease outbreaks, water use, and land use. For example, CGS 25-38 through 25-43, CGS 25-32, and CGS 34-36 enacted a series of laws in 1902 and 1915, respectively, to "prevent outbreaks of water related disease…, protect and preserve for future generations, . . ." Relative to source protection, Section 19-13-B32 of the CT PHC sets forth the standards for sanitation of watersheds as follows that have persisted to the present time:

"Unless specifically limited, the following regulations apply to land and watercourses tributary to a public water supply including both surface and ground water[15] sources:

a) As used in this section, "sewage" shall have the meaning found in section 19-13-B20 (a) of the public health code: "Toxic metals" shall be arsenic, barium, cadmium, chromium, lead, mercury and silver and the salts thereof: "high water mark" shall be the upper limit of any land area which water may cover, either standing or flowing, at any time during the year and "watershed" shall mean land which drains by natural or man-made causes to a public drinking water supply intake.

[15] "Ground water" is two words in this reference

b) No sewage disposal system, cesspool, privy or other place for the deposit or storage of sewage shall be located within one hundred feet of the high water mark of any reservoir or within fifty feet of the high water mark of any stream, brook, or watercourse, flowing into any reservoir used for drinking purposes.

c) No sewage disposal system, cesspool, privy or other place for the deposit or storage of sewage shall be located on any watershed, unless such facility is so constructed that no portion of the contents can escape or be washed into the stream or reservoir.

d) No sewage shall be discharged on the surface of the ground on any watershed.

e) No stable, pigpen, chicken house or other structure where the excrement of animals or fowls is allowed to accumulate shall be located within one hundred feet of the high water mark of a reservoir or within fifty feet of the high water mark of any watercourse as above mentioned, and no such structure shall be located on any watershed unless provision is made in a manner acceptable to the commissioner of health for preventing manure or other polluting materials from flowing or being washed into such waters.

f) No toxic metals, gasoline, oil or any pesticide shall be disposed of as a waste into any watercourse tributary to a public drinking water supply or to any ground water identified as supplying a public water supply well.

g) Where fertilizer is identified as a significant contributing factor to nitrate nitrogen occurring in excess of 8 mg/l in a public water supply, fertilizer application shall be made only under current guidelines established by the commissioner of health in cooperation with the state commissioner of agriculture, the college of agriculture of the University of Connecticut and the Connecticut agricultural experiment station in order to prevent exceeding the maximum allowable limit in public drinking water of 10.0 mg/l for nitrite plus nitrate nitrogen.

h) Where sodium occurs in excess of 15 mg/l in a public drinking water supply, no sodium chlorine shall be used for maintenance of roads, driveways, or parking areas draining to that water supply except under application rates approved by the commissioner of health, designed to prevent the sodium content of the public drinking water from exceeding 20 mg/l.

i) The design of storm water drainage facilities shall be such as to minimize soil erosion and maximize absorption of pollutants by the soil. Storm water drain pipes, except for crossing culverts, shall terminate at least one hundred feet from the established watercourse unless such termination is impractical, the discharge arrangement is so constructed as to dissipate the flow energy in a way that will minimize the possibility of soil erosion, and the commissioner of health finds that a discharge at a lesser distance is advantageous to stream quality. Special protections shall be taken to protect stream quality during construction."

In addition to the above requirements, stormwater discharges within 100 feet of a tributary to a public water supply reservoir must be reviewed and approved by the DPH. State statutes and regulations do not require watershed management per se, but they do require water utilities to conduct annual watershed surveys.

Regulation of water company land is an important component of source protection in Connecticut. In Connecticut, the sale and/or change of use of water company owned lands is regulated. A change in water company land associated with either a groundwater supply or a public water supply reservoir is reviewed and approved through a permit processes.

As explained Section 2.2.2 Conservation and Economic Development Trends, source protection has a key component in local land use application review processes. Developers and land use applicants in aquifer protection areas and public water supply watershed must notify water utilities and DPH of their application, and DPH may provide comments to local land use commissions and agencies.

The following table provides a list of statutes and regulations that address drinking watershed sanitation.

Regulations and Statutes Affecting Watershed Sanitation

Name and Citation	Description
Water Company Lands: P.H.C. Sections 25-37c-1 et esq. and 25-37d-1 et seq.	Regulates the sale and/or change of use of water company owned lands, along with defining watershed land classifications, and through Connecticut General Statute 25-32(b) controls the sale of watershed lands and changes in its present use through permit processes.
Source Abandonment: C.G.S. Sections 25-33k, 25-33l, & 25-33m	Regulates the sale and abandonment of public water supply sources.
Location of Cemeteries: C.G.S. Section 25-41	Prohibits the location of cemeteries within one-half mile of a public water supply reservoir.
Prohibition of Sewage Discharge: C.G.S Section 22a-417	Prohibits sewage discharge within a public water supply watershed area.
Sanitation of Watersheds: P.H.C. Section 19-13-B32 et. seq.	Mandates various separating distances from potential sources of pollution to the edge of an established watercourse within a public water supply watershed area or aquifer recharge area and requires that special protections be taken during construction to protect stream quality.
Watershed Survey: P.H.C. Section 19-13-B102(b)	Requires a water company having an active water source of supply under its control to conduct a sanitary survey of the watershed at least annually and report the results of this survey to the Department of Public Health by March 1st each year.
Sanitary Survey of a System Using Groundwater	In conducting a sanitary survey of a system using groundwater pursuant to P.H.C. Section 19-13-B102(e)(7)(E)(iii), information on sources of contamination within the delineated wellhead protection area shall be considered.

Name and Citation	Description
Watershed Prohibitions, Fishing, Passive Recreation & Penalties for Polluting a Reservoir: C.G.S. Sections 25-43, 25-43c and 43(a)	Prohibits (i.e., bathing, aircraft, and general pollution) and regulates specific activities (i.e., fishing from boats with electric motors, fishing from shoreline) on public water supply reservoirs and associated watershed. Allows passive recreation for both surface and groundwater source areas through a permitting process. Any person who causes or allows any pollutant or harmful substance to enter any public water supply reservoir is subject to a fine of not less than one hundred dollars or imprisonment for not more than thirty days, or both.
Threat of Pollution: C.G.S. Section 25-34 (a)	The Department of Public Health may make orders as it deems necessary to protect public drinking water sources or ice supplies for any pollution or threatened pollution, which, in its judgment is prejudicial to public health.
Orders to Correct Pollution: C.G.S. Section 25-32g	Allows, after investigation, the issuance of orders in writing to any person to discontinue, abate, alleviate or correct conditions or activities that constitute an immediate threat to public water supplies.
Monitoring Waivers	The department may grant a public water system a waiver from the monitoring requirement for certain chemicals pursuant to P.H.C. Section 19-13-B102(e)(7)(C)(xii) – (xvi) if the watershed or zone of influence is not subject to certain types of land uses, and for certain chemicals, where previous analytical results showed no detectable limit of the contaminant to be waived.
Review of Projects in a Watershed by The Department of Public Health: C.G.S Section 25-32f	Allows the State Department of Public Health to review and comment on proposed development projects and zoning changes within public water supply source water areas.
Water Company Review of Projects in a Source Water Area: C.G.S. Sections 8-3i and 22a-42f	Requires an applicant to either the municipal planning and zoning commission, zoning board of appeals or the inland wetlands commission to notify the water company of the proposed development if this proposal is within the water company's public water supply watershed area (8-3i also includes aquifer protection areas). The water company therefore has the opportunity to provide comments to the municipality concerning the development proposal.
Individual Water Supply Plans: C.G.S. Sections 25-32d and 25-32d-1 et seq.	Requires water companies which serve over 1,000 people to produce long-term water supply plans in which the water company must plan for adequate supply to meet projected demand for the next 50 years, which includes an evaluation of source water protection measures.
Regional Water Supply Plans: C.G.S. Section 25-33d through 25-33j	Mandates water supply planning on a regional basis. Regulations detail the creation of the regional water supply plan. Individual water supply plans are a part of this regional process.
Local Governmental Consideration of Public Drinking Water Sources: C.G.S. Section 8-2 & 8-23	Requires that a municipal plan of conservation & development and zoning regulations shall be made with consideration for the protection of existing and potential public surface and ground drinking water supplies.

WP1.6.3. Drinking Water Quality Management Plan[16]

Despite having some of the oldest source protection laws on the books, Connecticut has strived to make advances in source protection. The programs described above have accomplished significant source protection, but DPH has recognized the need for additional tools.

Drinking water source protection serves as the initial barrier to contaminants entering drinking water supplies, increasing the efficiency and cost effectiveness of available treatment while maintaining the relatively low cost of water delivery to the public consumer.

The phrase "Drinking Water Quality Management Plan" was first developed by the DPH in 2005. The DWQMP concept is similar to traditional source protection, but it emphasizes and focuses on the public health aspects of maintaining high-quality potable water supplies through the first barrier of the multi-barrier approach. The DWQMP approach is meant to highlight and spotlight drinking water quality and public health protection. The guidelines and recommendations for the DWQMP as set by the DPH were first articulated in a presentation entitled "*Drinking Water Quality Management Planning*," given in May 2006. In general, the DWQMP is a *locally based, comprehensive planning mechanism* to define and implement quality management mechanisms for public source water.

A regional DWQMP was completed in southeastern Connecticut in 2009. This DWQMP was developed to become a model for other collaborative DWQMPs to be developed in Connecticut. However, to date, few have been developed, and those that have been developed are site-specific rather than communitywide.

WP1-6.4. Source Water Collaborative

Source protection has gained traction again recently with establishment of the "Connecticut Source Water Collaborative." This is a group of organizations, including water utilities, non-governmental organizations, and government regulatory bodies, who are working together towards the protection of drinking water sources. A charter formalizing the group was signed on May 4, 2016. The mission, as laid out in the charter is to "facilitate collaborative approaches and creative solutions for drinking water protection through identification and implementation of complementary objectives, education, outreach, stewardship, and leveraging of resources." DPH anticipates that the collaborative will be helpful is promoting source water protection in the coming years.

WP1-6.5. Aquifer Protection Program[17]

The Aquifer Protection Area (APA) Program is Connecticut's wellhead protection program. Enacted in 1990, the APA Program applies to public water supply wells in stratified drift that serve more than 1,000 people (the state's most productive wells). The water company owning the well(s) maps the portion of the aquifer that contributes groundwater to the well in accordance with DEEP regulations. The mapping is approved by DEEP, and provided to the

[16] Final DWQMP Report

[17] http://www.ct.gov/deep/lib/deep/aquifer_protection/municipal_manual/3-apa_mapping.pdf

municipality. The municipality then adopts the mapping and imposes land use restrictions within the mapped area in a proactive effort to protect the well(s) from contamination.

The mapping is conducted in two phases: Level B is preliminary and provides a rough estimate of the contributing area to the wellfield. Level B mapping was completed in the early 1990s and provided to the towns for planning purposes. Level A mapping, or final mapping, is a refinement of Level B. The Level A mapping is based on extensive site-specific data and groundwater modeling. This mapping must be conducted in accordance with DEEP's mapping regulations [Section 22a-354b-1 of the RCSA], and DEEP must review and approve it. The shape and size of the area encompassed by the Level A mapping can be significantly different from the Level B area. As of 2016, most of the state's large groundwater sources have been mapped to Level A standards.

The Aquifer Protection Program has two other important components. The APA program defines 28 regulated activities that use, handle or store hazardous materials. Existing regulated activities in APAs must register and certify to best management practices. New businesses conducting these regulated activities are prohibited from locating in APAs. A permitting process allows changes to registered regulated activities in APAs. The final component of the program rests with the municipalities. Municipal commissions must adopt and implement local aquifer protection regulations and monitor the land uses in the aquifer protection areas. The APA program also requires municipalities to notify water utilities of proposed developments in aquifer protection areas.

WP1-7. Drought Management[18]

Droughts have occurred in Connecticut despite the fact that the state typically receives abundant precipitation. The most severe drought in recent history occurred during a multi-year period in the 1960s. Following a drought in the 1980s (the drought that spurred the coordinated water system planning process described above), a Drought Task Force was created as an independent standing committee to actively monitor conditions and recommend whether the state should declare a drought.

In 1999, the group was reestablished as the Interagency Drought Workgroup (IDW), which is responsible for assessing water conditions on a regional and/or state-wide basis, determining what level of concern is warranted based on the current conditions, communicating concerns to agency commissioners and the Governor, and drafting press releases. State entities represented in the group are OPM (lead), DEEP, PURA, DPH; the Department of Emergency Services and Public Protection (DESPP) including the Division of Emergency Management and Homeland Security (DEMHS), and the Department of Agriculture. The U.S. Geological Survey and the National Weather Service provide technical assistance to the Workgroup.

The IDW recognized the need to develop a set of formal operating procedures and administrative guidance to improve the function, effectiveness, and predictability of future drought response activities. Consequently, the IDW developed the original Drought Preparedness and Response

[18] CT Drought Plan DRAFT 6-29-2016B

Plan ("Drought Plan" or "Plan"). The Water Planning Council officially adopted the Drought Plan in 2003.

At the recommendation of the IDW and following a report on a table-top drought exercise in the Pomperaug River Basin conducted several years earlier, the WPC tasked the WPC Advisory Group in 2010 with an update to the Drought Plan. Significant changes in the updated draft Plan include a provision that drought declarations can apply to any geographic area; drought stage names were revised to clarify their severity and to avoid confusion with similarly-named stages in the Individual Water Supply Plans; and encouragement for the use of professional judgment concerning recommendations for drought declarations and related response activities. Enforceable actions are not identified. The draft Drought Plan identifies the following five stages of increasingly dry conditions:

- Heightened Awareness
- Below Normal Conditions
- Moderate Drought
- Severe Drought
- Extreme Drought

The draft plan has the following objectives:

1. Describe preparations that should be in place prior to a drought declaration in order for the state and municipalities to act when it becomes necessary (a section in Plan addresses long term planning for water conservation and drought preparation, not just prior to a drought declaration);
2. Define criteria and guidelines to assess drought conditions in order to determine which stage of drought is occurring in a given area;
3. Identify state, regional, local, federal, and private sector entities that are primarily responsible for managing drought-related activities;
4. Provide a guide for entities to undertake drought-related activities for which they are responsible, including coordination, public outreach, assessment, and preparedness;
5. Define communication strategies to integrate activities of the responsible parties;
6. Identify progressive water use restrictions that may be implemented at the state or local level for sufficient impact mitigation; and
7. Promote effective mobilization of public and private resources to manage drought mitigation efforts.

The draft plan recognizes a need to develop multiple model ordinances to address differing water systems and differing water needs in each community. Future revisions to this Plan will be made as needed or as additional data become available. These revisions may be done in coordination with the Plan.

WP1-8. Water Quality and Watershed Management

WP1-8.1. Water Quality Standards[19]

RCSA Sections 22a-426-1 through 22a-426-9, inclusive, and the Classification Maps adopted pursuant to Section 22a-426 of the Connecticut General Statutes, are known as the Connecticut Water Quality Standards. The purposes of the Connecticut Water Quality Standards are to:

1. provide clear and objective statements for existing and projected water quality and the general program to improve the state's water resources;
2. provide water quality for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water taking into consideration their use and value for public water supplies, propagation of fish, shellfish and wildlife, recreation in and on the water and agricultural, industrial and other purposes including navigation, wherever attainable;
3. recognize that surface and ground water[20] are interrelated and address the issue of competing use of ground waters for drinking and for wastewater assimilation;
4. ensure Connecticut's compliance with requirements of federal law requiring the promulgation of water quality standards and qualify the state and its municipalities for available federal grants for water pollution control;
5. establish designated uses for surface and ground waters and identify the criteria necessary to support those uses;
6. focus the department's water quality management activities, including establishment of water quality based treatment controls and strategies;
7. protect the public health and welfare and promote the economic development of the state; and,
8. be consistent with health standards as established by DPH.

The Connecticut Water Quality Standards are administered by DEEP. The Water Quality Standards include Surface Water Standards and Ground Water Standards. The Surface Water Standards are adopted in accordance with the federal Clean Water Act. The Ground Water Standards, while not required under the federal program, are parallel and provide important protection for drinking water sources just like the Surface Water Standards. The highest standards (such as AA and GAA) are protective of existing public water supply sources while the A and GA standards protect surface water and groundwater from pollution. The Ground Water Standards have important implications relative to the siting of certain land uses and activities, and they guide the level of remediation necessary per the Remediation Standard Regulations for certain contaminated sites.

The Water Quality Standards include three elements: Standards, Criteria, and a series of Classification Maps. The Standards designate use goals and set the overall policy for management of surface water and ground water quality. The Criteria include narrative and numeric criteria that prescribe the allowable parameters and conditions for various water quality classifications

[19] http://www.ct.gov/deep/lib/deep/regulations/22a/22a-426-1through9.pdf
[20] "Ground water" is two words in the Water Quality Standards

required to sustain the designated uses. The Classification Maps have been adopted and are amended from time to time. The Classification Maps show the water quality class assigned to each surface water and ground water resource throughout the state. The maps are used to relate designated uses and the applicable Standards and Criteria for each class of surface and ground water resource to a specific location.

As implied above, Connecticut uses only Class A or Class AA surface waters for drinking water. Section 22a-417 of the Connecticut General Statutes prohibits discharge of sewage to water supply impoundments. Therefore, Class B surface waters, which are designated in accordance with the Connecticut Water Quality Standards to, in part, receive and assimilate treated wastewater are not utilized for public drinking water supply. This topic is discussed extensively in Section 3.2.2, as the prohibition itself creates a set of challenges in the state, despite its numerous benefits.

WP1-8.2. Impaired Water Lists[21]

CWA Section 305(b) requires each state to monitor, assess and report on the quality of its waters relative to attainment of designated uses established by the State's Water Quality Standards. In Connecticut, DEEP is the agency with primary responsibilities to report on these CWA activities. Section 303(d) of the CWA requires each state identify and prioritize water quality limited waterbodies, and develop Total Maximum Daily Loads (TMDLs) or other management actions consistent with the Water Quality Standards for such impaired waters. These reports are brought together in the Integrated Water Quality Report (IWQR) which is submitted to the EPA every two years for review and approval. The state's current impaired waters list was approved by EPA on November 17, 2014.

WP1-8.3. Watershed Management Planning[22]

Watershed management is a term used to describe the process of developing land use and water management practices to protect and improve the quality of the water and other natural resources within a watershed. The DEEP created the Watershed Management Program to more effectively address water resource issues from an integrated watershed perspective. DEEP's program is separate than the DPH watershed management programs that address public water supply watersheds.

For purposes of watershed management, the state has been divided into major watershed basins along natural watershed boundaries. DEEP Watershed Managers work within these major watershed basins to assist communities in forming partnerships, drafting watershed based plans, and implementing environmental projects to restore and protect the state's water quality on a watershed-wide scale. To accomplish watershed goals, the Watershed Managers have several key responsibilities. These include:

- Serve as a central knowledge base about watershed areas in terms of natural features, water resource issues, and state and federal programs and activities.
- Help focus DEEP program activities on priority watershed management issues including protection of pristine water bodies and restoration of impaired waters.

[21] http://www.ct.gov/deep/lib/deep/water/water_quality_management/305b/2014_iwqr_draft_305b_303d.pdf
[22] http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325624&deepNav_GID=1654

- Assist in the development of comprehensive watershed management plans to protect and restore water quality, conserve resources, and enhance pollution prevention.
- Act as a liaison between municipalities, residents, citizen organizations and other stakeholders within watersheds to offer assistance and guide local land use decision making.
- Provide education and public outreach about watershed issues.
- Help to manage nonpoint source pollution related projects financed in part with funds from the Federal Clean Water Act (Sections 319, 104, 604).

The DEEP Watershed Management Program encourages the use of the EPA's "9 Elements of a Watershed Based Plan." The nine elements are worth noting here, and are:

1. Impairment – An identification of the causes and sources of pollution, that will need to be controlled to achieve the load reductions estimated to fix the impairment, and to achieve any other watershed goals identified in the watershed-based plan.
2. Load Reduction – An estimate of the load reductions expected for the management measures described. Spreadsheets and land cover mapping are typically employed in these models to estimate load reductions.
3. Management Measures – A description of the NPS management measures that will need to be implemented to achieve the estimated load reductions.
4. Technical and Financial Assistance – An estimate of the amounts of technical and financial assistance needed, and/or the sources and authorities that will be relied on, to implement this plan.
5. Public Information and Education – An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
6. Schedule – An expedited schedule for implementing NPS management measures identified.

The most recent watershed management plan developed in Connecticut and approved by DEEP is for the West River (New Haven, West Haven, and upstream communities). The Pomperaug River Watershed Coalition is in the process of developing a 9 element plan which will replace its existing watershed management plan.

7. Milestones – A description of interim, measurable milestones for determining whether NPS management measures or other controls are being implemented.
8. Performance – Criteria to determine whether loading reductions are being achieved over time, and if progress is being made towards attaining water quality standards and, if not, the criteria to determine if this plan, or a related TMDL, needs to be revised.
9. Monitoring – A monitoring component to evaluate the effectiveness of the implementation efforts over time.

Many watershed management plans have been developed in Connecticut (approximately 50) although not all of them have followed the 9-element process. It is important to note that the DEEP watershed management program typically does not address public water supply watersheds. This is one reason that the state may maintain different watershed management programs (the program described here, as well as the source protection programs described earlier). The watershed management and source protection programs are both integral and complimentary to one another.

WP1-9. Water Diversion Program[23]

WP1-9.1. Permitted Diversions

A significant piece of legislation regarding water quantity occurred with the passage of the Water Diversion Policy Act of 1982 (Sections 22a-365 through 22a-379 of the Connecticut General Statutes). This act established a permitting process for any new, non-exempted out-of-stream or instream "diversion" from the waters of the state (surface or groundwater), and is essentially the state's version of regulated riparian water law. A permit also ensures that the applicant complies with other policies governing the impact of a diversion such as the Flood Management Act, Inland Wetlands and Watercourses Act, and Endangered Species Act. However, The Water Diversion Policy Act does not directly prioritize water usage among competing users.

Over the years, DEEP has made significant progress in bringing the regulated community into compliance. Public Act 02-103 provided an opportunity for unpermitted diversions (which were eligible for registration) to be permitted, and a series of General Permits have been developed and reauthorized over the years to make it more straightforward to permit water withdrawals.

Water diversion permits are granted for either out-of-stream or instream uses. In this context, out-of-stream uses include withdrawals from ground or surface waters for use (e.g. public water supply, irrigation, industrial processes) as well as transfers of public water supply from one distribution system to another. Instream uses include physical watercourse alterations (e.g. impoundment, relocation, channelization) and stormwater detention or retention. Anyone who is not exempt from the diversion permit (described below) must apply for a permit to:

- withdraw groundwater from one or more wells joined in one system whose combined maximum withdrawal exceeds 50,000 gallons of water during any 24-hour period;
- withdraw surface water (including skimming of flood flows) in excess of 50,000 gallons during any 24-hour period;
- collect and discharge runoff, including storm water drainage, from a watershed area greater than 100 acres;
- construct or otherwise modify roadway crossings or culverts which provide detention or retention of watercourse flows either by design or default;

[23] http://www.ct.gov/deep/cwp/view.asp?a=2709&q=324178&deepNav_GID=1654

- relocate, retain, detain, bypass, channelize, pipe, culvert, ditch, drain, fill, excavate, dredge, dam, impound, dike, or enlarge waters of the state;
- transfer water from one water supply distribution system to another where the combined maximum withdrawal from any source supplying the system or interconnected systems exceeds 50,000 gallons during any 24-hour period; or
- modify a registered diversion (for example, modify the intended use of water or the way that it is used).

When applying for a water diversion permit, applicants must provide an analysis of the impacts of the proposed actions on various items including instream flow, designated water uses, water quality, wetlands, wildlife, wastewater assimilation, flood management, recreation, and power generation. The application must also include an evaluation of alternatives to the proposed action.

When making a decision on a water diversion permit application, DEEP must consider those factors listed in the authorizing statutes and regulations including, but not limited to, the environmental effects of the diversion and whether the proposed diversion: 1) is necessary, 2) is consistent with long-range water resource management, 3) is consistent with the state plan of conservation and development adopted pursuant to part I of Chapter 297 of the Connecticut General Statues, and 4) will not impair proper management and use of the water resources of the state.

Holders of diversion permits for out-of-stream uses are required to file annual reports as stated within the permit and permit conditions. These reports typically include a daily record of water withdrawals and sometimes other information such as water conservation summaries and nearby stream stage records.

WP1-9.2. Registered Water Diversions[24] [25]

Water diversions that were in use before July 1, 1982, and properly registered before July 1, 1983 are exempt from the permitting requirements of the Water Diversion Policy Act. There are over 1,800 registered diversions, which are valid in perpetuity, although some of the registrations are no longer in use because the registrant has ceased to exist and/or the land use has changed. Registrations are not water rights. Water rights are appropriated (and oftentimes they are adjudicated) and imply ownership of the water. In Connecticut, all water is "waters of the state" with the state acting as the steward. Instead of a water right, registrations are exemptions from permitting. The "right" of the water user who holds a registration is to continue using the water without being subject to the permitting requirements of the Water Diversion Policy Act, although it is recognized that many other laws may regulate such usage.

Many water sources were registered for much greater quantities than owners have used since that time, because the registered numbers reflect capacities of pumps, intakes, pipes, etc. This has been cited by many stakeholders as a reason that it is challenging to effectively allocate water uses in drainage basins because it can be difficult to understand the nature of a registration or

[24] http://www.ct.gov/deep/cwp/view.asp?a=2709&q=324178
[25] http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325638&deepNav_GID=1654%20

know how a water withdrawal has changed since its time of registrations. However, a holder of a diversion registration is entitled to take the maximum registered amount, and therefore it must be accounted for when evaluating a proposed new diversion through the permitting process.

Holders of registered water diversions are not subject to the same type of annual water use reporting requirements like some permittees. However, Public Act 02-102 required a one-time reporting of water withdrawal data for registered diversions for the years 1997-2002. Several years later, legislation was passed that called for annual reporting on an electronic form to be developed by DEEP in consultation with other state agencies and registered diverters. Such a form is yet to be created, and therefore registered diversion use reporting is currently not occurring. As such, the identified data gap has not yet been addressed.

WP1-10 Streamflow Regulations

WP1-10.1. Stream Classifications[26] [27]

The Connecticut Stream Flow Standards and Regulations were passed and became effective in 2011. They were enacted in 2005 as Public Act 05-142. The standards classify each stream in the state according to degree of alteration by human use and define minimum flow standards for each class that are intended to be protective of instream habitats. Although very complex, the regulations require releases of water from certain impoundments in accordance with the standards to support the instream habitat. It primarily affects registered surface water diversions. Ground water diversions are not affected by these release requirements.

The release requirements of the Stream Flow Standards and Regulations depend upon the designated classes of streams. Therefore, the first step for compliance with the Connecticut Stream Flow Standards and Regulations is the DEEP's classification of all watercourses. Classes of streams can be 1, 2, 3, or 4. Class 1 is closest to a natural flow regime, and class 4 represents a stream with significant alterations for the purposes of human consumption, public health and safety, flood control, industry, and other uses. In general, the classes require the following:

- Class 1 streams are essentially free-flowing. There shall be no manipulation of the storage of water behind a dam, and no withdrawals from the resulting impoundment, if the dam releases into a class 1 water body.
- Class 2 is described as a minimally altered stream flow conditions. A class 2 water body requires 75% of the natural inflow to be released.
- Class 3 is described as moderately altered. Certain class 3 water bodies require a variable release that is consistent with six "bioperiods." During the R&G bioperiod, the release rate is adjusted as necessary, up to twice per month to accommodate antecedent wet or dry conditions. Class 3 water bodies require a release consistent with the R&G BQ80.
- Class 4 is described as substantially altered streamflow. Class 4 water bodies must release water to the extent described in the narrative standards; that is, "exhibit to the maximum extent practicable the depth, volume, velocity, and variation of stream flow and water levels

[26] http://www.ct.gov/deep/lib/deep/regulations/26/26-141b-1throughb-8.pdf
[27] Milone & MacBroom

consistent with the narrative standard for class 3 river and stream segments." The allowable stream flows of class 4 waters must balance environmental conditions with existing channel modification, development of watershed, overriding societal needs, margin of safety in water system utilizing stream, and other factors.

Streams located in portions of eastern and south-central Connecticut have been classified, and classifications will continue until complete in the next few years. Most of the Class 3 segments are located downstream of public water supply reservoirs or adjacent to public water supply wellfields. By regulation, stream segments downstream from public water sources or adjacent to Level A aquifer protection areas cannot be classified as Class 1 or 2.

Implementation of the Stream Flow Standards and Regulations may reduce safe yield of some public water supply sources if significant releases are required. Safe yield reductions will reduce margins of safety and will need to be considered by water utilities in meeting DPH requirements for public water suppliers. It is noted that the streamflow regulations - Sections 26-141-6(b) and (c) – allow for alterations to flow requirements when drought or margin of safety criteria are triggered.

WP1-10.2. Program Compliance[28]

Any person owning or operating a dam subject to the Stream Flow Standards and Regulations shall, not later than one year after the date of publication of classification for a river or stream segment on which such owner's dam is located, submit certain information to the DEEP. In addition, the dam owner must state that it will develop a plan for making the infrastructure changes necessary, and begin making releases, to comply with the ten-year timeframe for compliance that was established in subsection (a) of section 26-141b-6 of the Regulations of Connecticut State Agencies.

At the present time, dam owners in eastern Connecticut are already in the first years of the ten-year period (with initial reporting due in October 2015), whereas those in south-central Connecticut are about to begin the ten-year compliance period.

Some of the water utilities that own regulated dams have begun estimating changes in safe yield that may occur as a result of making releases, and some have begun monitoring conditions downstream of dams to compare instream flows to the calculated bioperiod flows.

Nine years after stream classification, each dam owner required to make releases must submit for DEEP approval a description of methods and locations to be used to calculate releases and to demonstrate compliance with release flow requirements. Upon initiation of a release, each dam owner must maintain an operating log that documents the flow of water from the dam, with sufficient detail to demonstrate that release meets the applicable requirement.

There are numerous exceptions and exemptions to the Connecticut Stream Flow Standards and Regulations. Notable examples include FERC-regulated hydroelectric dams, recreational

[28] http://www.sots.ct.gov/sots/lib/sots/regulations/title_26/141b.pdf

impoundments without any alteration of water levels, and impoundments that are authorized by diversion permits. For various reasons, there are some public water supplies that are exempt.

WP1-11. Comprehensive State Energy Strategy[29] [30]

The DEEP developed the first-ever Comprehensive Energy Strategy for the State of Connecticut shortly after the consolidation of DPUC into DEEP to form PURA. This is an assessment and strategy for all residential, commercial, and industrial energy issues. The strategy was developed as called for in Public Act 11-80, passed in June of 2011. Section 51 of this Act requires that DEEP, in consultation with the Connecticut Energy Advisory Board (CEAB), prepare a Comprehensive Energy Strategy for Connecticut every three years.

DEEP issued a draft of the Comprehensive Energy Strategy for public comment on October 5, 2012. The final Strategy was issued February 19, 2013.

The State's Comprehensive Energy Strategy gives the state a more systematic basis for addressing energy opportunities and challenges. It provides a foundation for better informed policy, regulatory, and legislative decisions; as well as better energy choices at the household and business level. This Strategy covers all fuels in all sectors with a planning horizon out to 2050. The Strategy offers recommendations in five major priority areas: energy efficiency, industrial energy needs, electricity supply including renewable power, natural gas, and transportation.

With regard to water, the Strategy contains a section in Chapter 2 called "Addressing the Special Relationship between Energy and Water." The report notes that "the interface between energy and water crosses so many sectors that it is difficult to fit a discussion of the relationships, challenges, and opportunities in these areas entirely into this Chapter. The water industry itself includes public and private water companies that maintain water sources, treatment facilities, and delivery infrastructure and the wastewater treatment plants that collect, treat and discharge the water after its use. New drinking water regulations also require the use of more energy-intensive treatment technologies. Water is heavy (weighing 8.3 pounds per gallon), and pumping, extracting, treating, conveying and discharging it through its use cycle require enormous amounts of energy. A 2009 EPA report on water utilities found that globally, water utilities' biggest cost is energy, and that those costs can represent as much as 65% of a utility's annual budget. As a result, the rewards for reducing those costs through efficiency process and motor upgrades are large in terms of a water utility's overall economics. Conserving water means pumping less of it, thereby saving energy."

Consequently, one of the recommendations of the Strategy is to conserve water. The Strategy recommends that PURA encourage rate-setting that leads to conservation, and also recommended the expansion of the Water Infrastructure Conservation Adjustment (WICA) surcharge mechanism from 5% to 10%. This was subsequently accomplished by Public Act 13-78. WICA is an existing ratemaking tool that allows for interim rate adjustments, as approved by PURA, for eligible projects that improve system reliability, water quality and reduce water losses through main breaks and leaks for regulated water companies. These projects are otherwise eligible for

[29] http://www.ct.gov/deep/lib/deep/energy/cep/2013_ces_final.pdf
[30] http://www.ct.gov/deep/cwp/view.asp?a=4120&q=500752

recovery in rates, but the WICA mechanism provides a streamline, timely approval process between rate cases. The WICA surcharge is not available to all water utilities. It is only available to private investor-owned water utilities.

The next Comprehensive Energy Strategy for the state is under development, with scoping completed in spring 2016.

WP1-12. Coastal Management Program[31]

With the Blue Plan under development, it is not yet clear where the State Water Plan's "jurisdiction" will end. At the present time, it appears that the State's coastal area management may be germane to the State Water Plan. Therefore, a description of the State's coastal area management is provided in this report.

Public Act 15-66, An Act Concerning a Long Island Sound Blue Plan and Resource and Use Inventory, was signed on June 19, 2015 and went into effect on July 1, 2015. This "Blue Plan" legislation establishes a process by which Connecticut will develop an inventory of Long Island Sound's natural resources and uses and, ultimately, a spatial plan to guide future use of the Sound's waters and submerged lands. Currently, Connecticut's Coastal Management Program protects coastal resources and guides development along the state's shoreline. The development of a Blue Plan for Long Island Sound will supplement the Coastal Area Management Program's existing authority in the deeper offshore reaches of the Sound.

The United States Coastal Zone Management Act (CZMA) of 1972 emphasizes the primacy of state decision-making regarding the coastal zone. The DEEP Land & Water Resources Division (LWRD) administers Connecticut's federally-approved coastal zone management program pursuant to the CZMA, as amended. LWRD is funded by the State of Connecticut and NOAA.

LWRD coordinates with programs within the DEEP regarding activities that may have an impact on Long Island Sound and related coastal land and water. LWRD implements, oversees, and enforces the state's coastal management and coastal permit laws and regulations. Connecticut's coastal management policies are in Chapter 444 of the Connecticut General Statutes. Under the statutory umbrella of the Connecticut Coastal Management Act (CCMA) enacted in 1980, the Coastal Management Program ensures balanced growth along the coast, restores coastal habitat, improves public access, protects water-dependent uses, protects public trust waters, and promotes harbor management. The Coastal Management Program also regulates work in tidal, coastal and navigable waters [waterward of the coastal jurisdiction line (CJL)] and tidal wetlands under the CCMA (Section 22a-90 through 22a-112 of the Connecticut General Statutes), the Structures Dredging and Fill statutes (Section 22a-359 through 22a-363f) and the Tidal Wetlands Act (Section 22a-28 through 22a-35). Development of the shoreline landward of mean high water (MHW) is regulated at the local level through municipal planning and the zoning boards and commissions under the policies of the CCMA, with technical assistance and oversight

Coastal management in Connecticut is a rapidly changing program in many ways, with significant new laws passed in 2012 and 2013.

[31] http://www.ct.gov/deep/cwp/view.asp?A=2705&Q=323536

provided by LWRD staff. There is an area of overlapping state and municipal jurisdiction between the CJL and MHW.

The DEEP published the Coastal Policies and Use Guidelines manual in 1979 to guide coastal development. The Connecticut Coastal Management Manual replaced this guidance document in 2002. The Manual contains a number of project review checklists, coastal resource fact sheets, coastal use fact sheets, site plan examples, and a copy of the Connecticut Coastal Management Act as well as other regulations. Most importantly, the Manual describes Coastal Site Plans and explains when they must be referred by municipalities to DEEP.

In 2012, the Connecticut General Assembly passed Public Act 12-101, An Act Concerning the Coastal Management Act and Shoreline Flood and Erosion Control Structures. This legislation combined a number of initiatives to address sea level rise and to revise the regulatory procedures applicable to shoreline protection. For the first time, the concept of sea level rise was incorporated into the Connecticut Coastal Management Act relative to the general goals and policies of coastal planning.

From a regulatory standpoint, perhaps the most significant change brought about by PA 12-101 was the change in coastal permitting jurisdiction for statutes governing the placement of structures, dredging, and fill in tidal, coastal or navigable waters. Through its coastal permitting program, DEEP has had direct regulatory jurisdiction over activities occurring in tidal wetlands since 1970 and/or waterward of the high tide line since 1987. Between 1939 and 1987, the state regulatory jurisdiction line for coastal structures, dredging, and fill was at Mean High Water, which also marks the boundary between private and public trust property. Because the statute provided several methods of field-determining the jurisdictional high tide line, there were occasional disputes over the extent of DEEP's regulatory jurisdiction. As a result, effective October 1, 2012, the "high tide line" is changed to "coastal jurisdiction line" (CJL), which is a fixed elevation that can be derived by a surveyor in accordance with a specified methodology. The CJL was developed to roughly approximate the location of the high tide line that DEEP had been using, and will be adjusted to reflect sea level rise upon the promulgation of tidal data from the next tidal epoch.

PA 12-101 also allows DEEP to establish a pilot program to encourage "innovative and low-impact approaches to shoreline protection and adaptation to a rise in sea level. Such approaches may include living shorelines techniques utilizing a variety of structural and organic materials, including, but not limited to, tidal wetland plants, submerged aquatic vegetation, coir fiber logs, sand fill and stone to provide shoreline protection and maintain or restore coastal resources and habitat."

Special Act 13-9, An Act Concerning Climate Change and Data Collection, allowed the state to establish a "Center for Coasts" to conduct research, analysis, design, outreach and education projects to guide the development and implementation of technologies, methods and policies that increase the protection of ecosystems, coastal properties and other lands and attributes of the state that are subject to the effects of rising sea levels and natural hazards. Subsequently, DEEP teamed with the University of Connecticut to establish the Connecticut Institute for Resilience and Climate Adaptation (CIRCA). CIRCA has been actively engaged in outreach, education, local partnerships, and dispensing of funds in 2014, 2015, and 2016.

Public Act 13-179 clarifies several Connecticut statutes by making reference to the National Oceanic and Atmospheric Administration (NOAA) sea level rise discussions in Technical Report OAR CPO-1 (Global Sea Level Rise Scenarios for the United States National Climate Assessment, December 6, 2012). Pursuant to this Act, the definition of sea level rise was changed as follows: "Rise in sea level" means the arithmetic mean of the most recent equivalent per decade rise in the surface level of the tidal and coastal waters of the state, as documented in National Oceanic and Atmospheric Administration online or printed publications for said agency's Bridgeport and New London tide gauges. The Act states that municipalities shall consider sea level rise when developing Plans of Conservation and Development, and also states that in the preparation of any municipal evacuation plan or hazard mitigation plan, a municipality shall consider sea level change scenarios published by NOAA.

WP1-13. Flood Management[32]

The U.S. Congress established the National Flood Insurance Program (NFIP) on August 1, 1968, with the passage of the National Flood Insurance Act. The NFIP is a federal program administered by FEMA enabling property owners in participating communities to purchase insurance protection against losses from flooding. The State of Connecticut and all of its municipalities participate in the NFIP.

Participation in the NFIP is based on an agreement between local communities and the federal government that states if a community adopts and enforces a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

The State of Connecticut has its own floodplain management program which started from an executive order, E.O No. 18, issued by Governor Ella Grasso in June of 1977. The program was later codified through legislative act with the creation of Section 25-68 of the Connecticut General Statutes, the Flood Management Act. The Flood Management Act requires all state agencies, when undertaking or funding activities within or affecting floodplain areas, to submit an application for a Flood Management Certification to DEEP prior to conducting such activity. In making a decision to approve or reject a state agency's flood management certification, DEEP must consider whether the proposed activity: is consistent with state standards and criteria for preventing flood hazards to human life, health or property and with the provisions of the National Flood Insurance Program (NFIP) and municipal floodplain regulations; does not adversely affect fish populations or fish passage; and does not promote intensive use and development of flood prone areas. There are many aspects of the Flood Management Act that go beyond the minimum standards set forth in the National Flood Insurance Program.

Over the years there has been legislative changes in the Flood Management Act to keep up with changes in the federal program. During the 2004 session, the state legislature passed the Floodplain Management and Hazard Mitigation Act. This legislation covers many aspects of floodplain management. It requires municipalities to revise their current floodplain zoning

[32] http://www.ct.gov/deep/cwp/view.asp?a=2709&q=324172&deepNav_GID=1654

regulations or ordinances to include new standards for compensatory storage and equal conveyance of floodwater. The DEEP developed model regulation language which incorporates these new state requirements and has issued this model floodplain ordinance to communities for their use since 2007.

Other enabling state legislation related to flood plain management includes:

- Sections 22a-36 through 22a-45, inclusive – Inland Wetlands and Watercourses Act;
- Section 22a-401 through 22a-410, inclusive – Dam Safety;
- Section 13a-94 – Construction Over and Adjacent to Streams;
- Section 25-84 through 25-98 – Flood & Erosion Control Board Statutes;
- Section 22a-318, 22a-321 – NRCS Statutes;
- Section 25-74 through 25-76 – Authorization to perform flood and erosion projects under federal authority; and,
- Section 22a-365 through 22a-378 – The Connecticut Water Diversion Policy Act (especially through its requirements for various instream diversions).

Connecticut adopted a Natural Hazards Mitigation Plan Update in January 2014 to continue meeting guidelines set forth in the Disaster Mitigation Act of 2000. This Plan describes the state's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis, and furthers shifts the state from a disaster-response driven system to one based on effective hazard mitigation planning. The update references the additional challenges that climate change poses to the state.

WP1-13.1. Dam Safety[33]

The dam safety statutes are codified in Sections 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies have been enacted, which govern the registration, classification, and inspection of dams. The DEEP administers the statewide Dam Safety Program and designates a classification to each state-registered dam based on its potential hazard.

The State's dam safety program is closely aligned with its flood management program. Due to the relationship between dams and water supply (described above), streamflow regulations (described above), and fish passage (described below), a detailed description of the dam safety program is provided herein.

- Class AA dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways and structures and negligible economic loss.
- Class A dams are low hazard potential dams that upon failure would result in damage to agricultural land and unimproved roadways, with minimal economic loss.

[33] Text adapted from Hazard Mitigation Plans prepared by Milone & MacBroom, Inc.

- Class BB dams are moderate hazard potential dams that upon failure would result in damage to normally unoccupied storage structures, damage to low volume roadways, and moderate economic loss.
- Class B dams are significant hazard potential dams that upon failure would result in possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, and the like; damage or interruption of service of utilities; damage to primary roadways; and significant economic loss.
- Class C dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways, with great economic loss.

Dam inspection regulations require that nearly 1,300 dams in Connecticut be inspected on a consistent basis, with high hazard dams being inspected most frequently at an interval of once every 2 years. The DEEP currently prioritizes inspections of those dams that pose the greatest potential threat to downstream persons and properties. Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the DEEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's Office for enforcement.

Owners of Class C dams have traditionally been required to maintain Emergency Operation Plans (EOPs). Guidelines for dam EOPs were published by DEEP in 2012, creating a uniform approach for development of EOPs. Important dam safety program changes are underway in Connecticut. Public Act No. 13-197, An Act Concerning the Dam Safety Program and Mosquito Control, passed in June 2013 and describes new requirements for dams related to registration, maintenance, and EOPs, which will be called emergency action plans (EAPs) moving forward. This Act requires owners of certain unregistered dams or similar structures to register them by October 1, 2015. The Act generally shifts regularly scheduled inspection and reporting requirements from the DEEP to the owners of dams. At the present time, the owner of any high or significant hazard dam (Class B and C) must develop and implement an EAP pursuant to regulations for EAPs adopted in 2016. The EAP shall be updated every 2 years, and copies shall be filed with DEEP and the chief executive officer and the emergency management officer of any municipality that would potentially be affected in the event of an emergency.

WP1-14. Inland Wetlands Regulations[34]

Many activities that involve management of water will also involve wetlands. Inland wetlands in the State of Connecticut are protected by the 1972 Inland Wetlands and Watercourses Act (IWWA, sections 22a-36 through 22a-45 of the General Statutes). In the state of Connecticut, inland wetlands are defined by soil types.

It is the public policy of the State of Connecticut to require municipal regulation of activities affecting the inland wetlands and watercourses within the territorial limits of the various municipalities.

[34] IWWA, sections 22a-36 through 22a-45 of the General Statutes of Connecticut

This allows inland wetlands to be easily identified in periods of drought, where soil moisture may not be present, and during winter, when characteristic vegetation may be absent. This is more inclusive (conservative) than the federal definition of wetlands under the Federal Clean Water act, which requires soil characteristics, hydrophytic vegetation, and wetlands hydrology.

The IWWA provides an regulatory permitting process that balances the need for economic growth of the state with the need to conserve and protect inland wetland and watercourse resources. Further, the IWWA delegates implementation and enforcement of this process to municipalities. Therefore, the majority of activities that are likely to impact or affect inland wetlands and watercourses are regulated at the local level (projects conducted by state agencies or on state land are regulated by DEEP). In issuing a permit to conduct an activity that may impact or affect an inland wetland or watercourse, the municipal inland wetlands agency can consider mitigation measures that will prevent or minimize environmental damage, or maintain or enhance existing environmental quality.

The IWWA allows certain operations to be performed in inland wetlands and watercourses without a permit. These include uses incidental to the enjoyment and maintenance of residential property, grazing, farming, nurseries, gardening and harvesting of crops and farm ponds of three acres or less essential to the farming operation, withdrawals of water for fire emergencies, certain public water supply operations, recreation and conservation, and activities conducted by, or under the authority of, the DEEP for the purposes of wetland or watercourse restoration or enhancement or mosquito control. The municipal inland wetlands agency is legally entitled to review the proposed operation to determine if a permit is or is not needed.

An individual who proposes an activity regulated by one of the many other programs described in this paper (for example, certain activities regulated under the water diversion program) may also find that a municipal inland wetlands permit is required. In some cases, the need for a state permit (such as Dam Safety) will preclude the need for a local wetland permit.

WP1-15. Wastewater Management

WP1-15.1. Clean Water Act[35] [36]

Legislative interest in water pollution began in 1887 when the Connecticut General Assembly authorized the formation of a sewer study commission to investigate the subject of "sewage disposal." The commission report (1889) recommended the state seek to stop further pollution. Similar legislative study commissions were created in 1913 for the investigation of factory wastes and, again, in 1921 to investigate solutions to eliminate pollution. Finally, in 1925 laws were enacted to create a State Water Commission. The Commission's lack of regulatory authority greatly limited its effectiveness. By the mid-1960s, water quality conditions

Connecticut's early regulation of wastewater – years before federal regulation – is similar to the State's early regulation of drinking water before the formation of EPA and the passage of the SDWA.

[35] https://www.epa.gov/sites/production/files/documents/actionplan101409.pdf
[36] https://www.epa.gov/enforcement/water-enforcement#cwa

in many parts of the state were so poor that public outcry and governmental interest increased, starting the process for major change.

In 1967, the State's Clean Water Act was passed, ushering in the state's modern water pollution control program. Significant new authorities enabled the former Water Resources Commission to require new stringent wastewater treatment for municipal sewerage facilities and industrial discharges. The Oil Pollution Act was passed two years later to create an emergency spill response program to deal with pollution from spills and leaks. The state's initial Water Quality Standards were approved in 1970, with Ground Water Quality Standards initially added in 1980.

The Federal Water Pollution Control Act was passed in 1972. This was the nation's first comprehensive water pollution law. It is believed to be modeled, in part, on Connecticut's Clean Water Act. The Federal Water Pollution Control Act calls for elimination of discharges to the nation's waters and mandates planning, regulation, and enforcement.

Connecticut's Clean Water Fund (CWF) program was created in 1986. The CWF provides financial assistance in the form of grants and low interest rate loans to municipalities for their water pollution control projects. Typical projects funded through this program include water pollution control facility (WPCF) upgrades which include nutrient (nitrogen and/or phosphorus) removal, combined sewer overflow (CSO) elimination, sewer extensions to resolve pollution problems created by substandard septic systems, and sewer system rehabilitation of pipes and pumping systems. The CWF covers engineering services costs in the planning and design phase of project, and engineering and construction costs to build the project. The project financing is based upon state statute. Grants vary based upon the type of project and range from a 20% grant to a 55% grant. Project loans are at a 2% interest rate and paid back to the state over 20 years. Funding for the CWF program is from state general obligation bonds (pays for the grant), state revenue bonds (pays for the loan) and a federal capitalization grant (pays for grants and loans). Currently, the funding from the state represents 90% of the funding in the CWF program.

The state legislature continues to provide financial support for the CWF program. Since the inception of the CWF program, $3.5 billion in grants and loans have financed water pollution control projects throughout the state. In the past five years, the average funding to new projects was $217 million per year. In fiscal year 2016, the CWF program provided $578 million for funding new projects. DEEP anticipated that the demand for funding will remain high as projects for CSO control and phosphorus removal at WPCFs continue to advance from planning, to design and into construction.

The DEEP web sites notes that "many rivers, streams, and lakes are cleaner now than they have been in the past 100 years. Rivers such as the Willimantic, Naugatuck, Pequabuck, Quinnipiac, Connecticut and Farmington, once seriously polluted, are now used for many recreational pursuits…. Though we have cleaned up most of our worst problems, we have major issues yet to be fully addressed, such as hypoxia (low dissolved oxygen) in Long Island Sound, combined sewer overflows and groundwater contamination." Some of the individual programs described below are making gains in these areas.

WP1-15.2. Water Pollution Control Authorities[37]

Through their Water Pollution Control Authority (WPCA), the state's municipalities are responsible for managing the wastewater generated within their boundaries. For rural towns, this responsibility may require only the development and implementation of a water pollution control plan (WPCP). However, most municipalities have more complex wastewater management needs and their responsibilities are correspondingly more complex.

WP1-15.3. Municipal Facility Planning[38]

For most Connecticut municipalities, wastewater management issues are too complex to be adequately addressed solely by a WPCP. In these instances, the WPCP may be supplemented with a Municipal Wastewater Facilities Plan (MWFP). An MWFP (often referred to as a "facilities plan") is a document produced by or for a municipal WPCA that guides the conveyance or treatment of wastewater. A complete MWFP is often, but not always, a series of documents that provide a clear description of existing conditions including identification of problem areas, an analysis of alternatives and costs, and a WPCA's long-term intentions for managing their wastewater disposal needs.

WP1-15.4 Discharges to Surface Water

Under the CWA's National Pollutant Discharge Elimination System (NPDES) program, EPA and DEEP regulate discharges of pollutants from municipal and industrial wastewater treatment plants, sewer collection systems, and storm water discharges from industrial facilities and municipalities. EPA established the NPDES program after the enactment of the CWA in 1972 to control discharges by establishing permits with discharge limits protective of water quality standards (such as those described above) and enforcing compliance with those permits. With only a few exceptions, EPA has authorized states to implement and enforce these programs across the country. EPA retains independent enforcement authority in authorized states and has responsibility to ensure that state programs are nationally consistent in writing quality permits and enforcing them. The Clean Water Action Plan targets enforcement to the most important water pollution problems.

EPA's oversight of state NPDES programs has focused primarily on how well states are addressing the largest direct discharge facilities that have continuing problems. EPA has fairly complete information about these biggest facilities, as the facilities are required to submit monthly reports of their compliance with their permit limits in submissions called Discharge Monitoring Reports (DMRs).

WP1-15.5. Subsurface Sewage Disposal Programs[39] [40]

In Connecticut, the term "septic system" typically refers to subsurface sewage disposal systems. Septic systems on sites with design flows of less than 5,000 gallons per day are permitted by the

[37]http://www.ct.gov/deep/lib/deep/land_resources_and_planning/primer/themunicipalprimer_wastewaterplanning.pdf
[38]http://www.ct.gov/deep/lib/deep/land_resources_and_planning/primer/themunicipalprimer_wastewaterplanning.pdf
[39] http://www.ct.gov/dph/cwp/view.asp?a=3140&q=387438&dphNav_GID=1828&dphPNavCtr=|#47142
[40]http://www.ct.gov/deep/lib/deep/land_resources_and_planning/primer/themunicipalprimer_wastewaterplanning.pdf, pg. 12

local Director of Health. Additionally, plans for large septic systems serving buildings with design flows of 2,000 to 5,000 gpd must be approved by DPH. On the other hand, DEEP is charged with permitting of large septic systems on sites with design flows exceeding 5,000 gpd, alternative sewage disposal systems, and community sewage systems. These regulatory distinctions are often confusing and therefore it is critical that local health districts and departments provide direct linkage to the state programs when necessary. This is similar to the way in which local health districts and departments provide direct linkage to DPH when reviewing new well water supplies that may or may not be regulated by DPH. Decentralized wastewater management districts are an approach to managing wastewater in areas characterized by multiple and scattered subsurface sewage treatment and disposal systems. These districts may be found in the state's rural towns and certain shoreline towns. There are three types of wastewater systems that can be used in a decentralized approach:

- A conventional subsurface sewage treatment and disposal system (conventional system), which consists of a house sewer connected to a septic tank connected to a leaching field, along with any necessary pumps or siphons and any groundwater control system on which the operation of the leaching field is dependent;
- A community subsurface sewage treatment and disposal system (community system), which is defined in statute as any sewerage system serving two or more residences in separate structures. Most community systems are not connected to a municipal sewerage system; however, some may be part of a municipally-managed decentralized wastewater management district; and
- An alternative subsurface sewage treatment system (AT system), which is often designed for nutrient reduction (typically nitrogen).

A decentralized wastewater management district can rely on one of these approaches or it can include a combination of conventional systems, community systems and alternative systems. Municipalities have authority to create decentralized wastewater management districts, which are areas designated by the municipality through a local ordinance. Approval of decentralized management districts typically requires a municipal commitment to upgrading individual systems to a pre-determined standard, through conventional septic systems, alternative technology, or both. A key to a successful district is the continued management by the municipality. Municipalities must assure the effective operation and maintenance of any new community sewerage system. This may contribute to the apparent limiting of their numbers in the state.

WP1-16. Climate Resiliency for Wastewater Treatment Facilities[41]

In accordance with Public Act No. 08-98, An Act Concerning Connecticut Global Warming Solutions, Section 7 required the Governor's Steering Committee on Climate Change to establish an Adaptation Subcommittee to evaluate the projected impacts of climate change on Connecticut

[41] http://www.ct.gov/deep/lib/deep/climatechange/connecticut_climate_preparedness_plan_2011.pdf

agriculture, infrastructure, natural resources and public health and develop strategies to mitigate these impacts. In more recent years, the importance of climate resiliency for wastewater treatment plants has been discussed as it pertains to Clean Water Act based projects in the state of Connecticut. The ability for wastewater treatment facilities to adapt to climate change will be critical to future water quality within Connecticut.

In particular, Public Act 13-15 requires the Commissioner of DEEP, when establishing the SRF priority list, to consider the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level rise over the projected life span of the projects. Currently, the Department requires that for all CWF projects, design criteria must adhere to the minimum protection levels included in the Connecticut Flood Management Act (CGS 25-68) and TR-16 guidelines. TR-16 (Guides for the Design of Wastewater Treatment Works) requires elevation or flood-proofing of critical or sensitive equipment. All new wastewater infrastructure must be able to provide for uninterrupted operation and be protected from physical damage during a 100-year storm.

Extreme precipitation events will put additional pressure on storm sewer systems and therefore further stress the remaining combined sewer/stormwater systems that continue to exist in older, urban areas. While predictions of the impact of climate change on specific facilities depends on the accuracy of predictive tools for precipitation patterns, increased rainfall or more intense storm events is likely to impact the effectiveness of long-term control plans for combined sewer systems and result in higher and more frequent overflow volumes with greater environmental impact. Therefore, climate change effects must be considered in adaptation planning as a part of Combined Sewer Overflow (CSO) abatement long-term control plans to facilitate wastewater treatment facility preparedness for climate change. Facilities in larger, older urban areas, especially Bridgeport, Hartford and New Haven, are most at risk and could be identified with individual adaptation plans.

WP1-17. Stormwater Management

Connecticut manages storm water through a variety of programs. These programs aim to reduce the quantity, and improve the water quality of storm water. Major permit programs include those described below.

WP1-17.1 Connecticut Stormwater Quality Manual

The Connecticut Stormwater Quality Manual was published by DEEP in 2004 for use as a planning tool and design guidance document. The manual provides uniform guidance for developers and engineers on the selection, design, and proper application of stormwater BMPs. In the 12 years since its publication, the Manual has been extremely useful in guiding the design of many development projects in the state.

WP1-17.2 Commercial and Industrial Stormwater Pollution Prevention[42]

EPA has mandated a number of permit programs that are administered by DEEP to address and control stormwater pollution:

[42] http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325702

- The General Permit for the Discharge of Stormwater Associated with Industrial Activity ("Industrial General Permit") regulates industrial facilities with point source stormwater discharges that are engaged in specific activities according to their Standard Industrial Classification (SIC) code.
- The General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities ("Construction General Permit") requires developers and builders to implement a Stormwater Pollution Control Plan to prevent the movement of sediments off construction sites into nearby water bodies and to address the impacts of stormwater discharges from a project after construction is complete.
- The General Permit for the Discharge of Stormwater Associated with Commercial Activity ("Commercial General Permit") requires operators of large paved commercial sites such as malls, movie theaters, and supermarkets to undertake actions such as parking lot sweeping and catch basin cleaning to keep stormwater clean before it reaches water bodies.

WP1-17.3. MS4 Permits and Program

One of the most important EPA-mandated, DEEP-administered regulatory tools for stormwater is the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (known as the "MS4 General Permit"). The NPDES Storm Water Program, in place since 1990, regulates discharges from municipal separate storm sewer systems (MS4s). The state's program requires each municipality to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies. The MS4 program is complex and requires mapping of systems and outfalls, reporting, and use of BMPs. One key important element of this permit is the requirement that towns implement public education programs to make residents aware that stormwater pollutants emanate from many of their everyday living activities, and to inform them of steps they can take to reduce pollutants in stormwater runoff.

WP1-17.4 Low Impact Development[43]

In February 2016, UConn published the report "The State of Low Impact Development in Connecticut" (http://nemo.uconn.edu/publications/2016stateofLID.pdf). This report provides a "State of the State" for LID policy implementation in the State's municipalities.

Low impact development is an alternative way of developing land and managing stormwater that is aimed at minimizing the impacts of urbanization on natural habitats and hydrology. The creation of hardened surfaces such as roads, parking lots and rooftops in combination with culverts and other structures that alter the natural movement of water all contribute to degraded rivers and streams. The overall goal of LID is to design with nature in mind by working with the natural landscape, hydrology and unique features of a site to avoid unnecessary water pollution, environmental degradation, and flooding. LID accomplishes this by controlling runoff close to the point of generation and retaining more water on the site where it falls, rather than funneling it into pipes that drain into local waterways. Stormwater management techniques within LID are meant to control stormwater at its source. This occurs through the application of four key principles:

[43] http://www.ct.gov/deep/cwp/view.asp?a=2719&q=459488

- Minimizing site disturbance
- Working with site hydrology
- Minimizing and disconnecting impervious surface
- Applying small-scale controls at the source

DEEP is in the process of evaluating the incorporation of LID principles into the State's Stormwater General Permits, which were described above, and the state's various manuals including the aforementioned Connecticut Stormwater Quality Manual as well as the Connecticut Guidelines for Soil Erosion and Sediment Control. DEEP intends to:

- Establish LID and pollution prevention, performance goals, and criteria for management practices common to Stormwater General Permit implementation;
- Identify how the performance goals and criteria can be most effectively incorporated into the Stormwater General Permit(s) to meet permit limits and conditions; and
- Identify mechanisms for incorporating LID BMPs and pollution prevention practices into the Stormwater General Permit(s) for priority attention.

DEEP also intends this process to explore several critical aspects of current and developing stormwater management practices to protect receiving waters and to provide clear regulatory guidance for the regulated community to effectively comply with permit requirements. This means providing the technical, planning and design tools necessary for effective site design, as well as a framework for broader compliance of the municipal regulatory community. These critical aspects include:

- Use of runoff volume as an indicator of environmental effect
- Relationship between volume control and pollutant control
- Appropriate permit limits for runoff volume relative to storm size
- Necessary guidance including performance criteria for LID and pollution prevention and end-of-pipe BMPs
- Role and benefit of stormwater utilities
- Building LID, stormwater utilities, and other management tools into permits and guidance
- Expanding the approach to other general permits such as the MS4 and Industrial Stormwater General Permits.

WP1-18. Recreational Management

WP1-18.1. Public Access Management[44]

The state's system of state parks, state forests, state boat launches, and waterways provide opportunities for outdoor recreation. These range from camping and

Although provision of public access to marine waters is sought and managed somewhat differently than public access to inland waters, both are important components of providing access to waters statewide.

[44] http://www.ct.gov/deep/cwp/view.asp?a=2695&q=322630&deepNav_GID=1

fishing to hiking, boating, and picnicking. The DEEP Bureaus of Outdoor Recreation and Natural Resources lead the agency's outdoor recreation efforts by acquiring and managing lands with an eye toward providing public use and access that is compatible with long term protection of natural resources.

Connecticut's recreational water bodies are patrolled and protected by the State Environmental Conservation Police. Aside from enforcing State Fish and Game laws, the State Environmental Conservation Police also address wildlife management concerns, provide enforcement of regulated activities like boating, provide public outreach regarding environmental issues, and provide homeland security protection.

Many water utilities allow passive or active recreation in public water supply watersheds. For example, MDC allows use of trails in its watershed lands and The Connecticut Water Company permits use of boats in Shenipsit Reservoir. However, water utilities do not uniformly allow different types of recreation, and many do not allow any recreation in watershed lands.

WP1-18.2. Fisheries Management[45]

The DEEP maintains several fisheries management programs including inland fisheries, marine fisheries, diadromous (i.e. anadromous and catadromous) fisheries restoration, Habitat Conservation and Enhancement, and support for recreational fishing via a three-hatchery coldwater (salmonid) fish culture system and an Aquatic Resource Education Program. Species specifically managed include Black Bass (largemouth and smallmouth bass), Channel Catfish, Atlantic Salmon, Kokanee Salmon (i.e. landlocked Sockeye Salmon), Northern Pike, three species of trout (brook, brown and rainbow), and Walleye. Additionally, the DEEP performs periodic electrofishing surveys of the state's lentic- and lotic-waters in order to estimate fish species richness, age distribution, abundance and diversity.

In 1979, stream flow regulations were established on waters stocked with fish by the state that required impoundment owners to release an essentially flat-rate discharge of water to stocked streams and rivers, plus a higher spring freshet release. These stream flow regulations were later determined to be insufficient in providing ecologically protective instream flows and they will be supplanted by the recently adopted Streamflow Standards and Regulations.

WP1-18.3 Dam Removals and Fish Passage[46]

Due to its prolific manufacturing past, Connecticut hosts a large number of dams along rivers and streams. Often times, dams become a barrier to migratory fish species, and can restrict downstream flow, altering ecological conditions.

Unlike nearby states like Vermont and Massachusetts, Connecticut does not have a state-funded, coordinated fish passage and dam removal program. State officials from DEEP may make a recommendation for dam removal or installation of a fish ladder, but there are often no reliable sources of funds available on the state

Organizations like Trout unlimited and the Nature Conservatory, which have vested interests in fish and wildlife populations, are common sources of funding for fish passage and dam removal projects.

[45] http://www.ct.gov/deep/cwp/view.asp?A=2696&Q=322646
[46] Correspondence with Jim MacBroom- Milone & MacBroom

level for these projects. In some cases, such as in Seymour and in the Housatonic Basin, mitigation funds from environmental penalties can be allocated by the state to dam removal efforts, among other projects. The Housatonic Basin projects were funded by mitigation money due to PCB pollution by General Electric in Pittsfield, MA, and the Seymour project was funded by mitigation funds associated with expansion of the sewage treatment facility in Waterbury.

Upon inspecting a dam in disrepair, DEEP's inspectors, or an engineer retained by the owner, will typically advise the owner of the option of removing, replacing, or repairing the dam. If the owner wishes to remove the dam, funding may be available through a number of public and private entities.

WP1-19. Connecticut Environmental Policy Act (CEPA)[47]

CEPA (CGS §§ 22a-1 through 22a-1h and Conn. Agencies Regs. § 22a-1a-1 through 22a-1a-12) is meant to ensure that state agencies consider environmental factors when deciding whether to take an action that may significantly affect the environment. It requires them to evaluate, in writing through an Environmental Impact Evaluation (EIE), the impact the proposed action would have on the environment. CEPA is often cited as the state version of the National Environmental Policy Act (NEPA).

Evaluation of impacts to water resources is a central component of almost all of the EIEs conducted pursuant to CEPA. In addition, some EIEs are developed for actions that are largely *about* water, such as water supply or flood mitigation.

The state legislature approved CEPA (PA 73-562) in 1973PA 73-562 included a provision that the public have access to, and the ability to comment on, state agency proposals.

In 2002, the legislature adopted PA 02-121, which adds a "scoping" process that allows the public to comment on a proposed action before an agency begins the formal EIE process.

At the present time, a CEPA evaluation is conducted through scoping and completion of an environmental impact evaluation, or EIE. Each EIE is overseen by a sponsoring agency such as DEEP, DPH, the Department of Economic and Community Development (DECD), UConn, or the Department of Construction Services (DCS). An EIE must examine the direct, indirect, and cumulative environmental consequences of a proposed action, and any reasonable alternatives to it (CGS § 22a-1b(c)). OPM reviews EIEs and determines if the applicable agency has taken all practicable steps to avoid or minimize environmental harm.

2.2.2 Land Conservation and Economic Development Plans

This paper outlines land management, and summarizes land conservation plans and economic development patterns, trends, or plans as available by region. While it draws upon localized examples, this is a general examination of trends and practices at the regional level.

[47] Source: https://www.cga.ct.gov/2008/rpt/2008-R-0079.htm

WP2-1. Local Planning

WP2-1.1. Municipal Plans of Conservation and Development

Chapter 126, Section 8-23 of the Connecticut General Statutes requires that municipal planning commissions "prepare, adopt and amend a plan of conservation and development for the municipality" once every ten years. A Plan of Conservation and Development (POCD) is the official statement from a municipality setting forth its goals and aspirations for the future land use, development, and environment of the community. POCDs typically include information about the current housing stock, utilities, roads, parks and recreational facilities, natural features, and other valuable resources as well as strategies for how those features should be improved or maintained in future years. Among many things that the POCD should include, it shall consider protection of existing and potential public surface and ground drinking water supplies (see text box).

> In preparing a POCD, the community shall consider the following: (1) the community development action plan of the municipality, (2) the need for affordable housing, (3) the need for protection of existing and potential public surface and ground drinking water supplies, (4) the use of cluster development and other development patterns to the extent consistent with soil types, terrain and infrastructure capacity within the municipality, (5) the state plan of conservation and development adopted pursuant to chapter 297, (6) the regional plan of conservation and development adopted pursuant to section 8-35a, (7) physical, social, economic and governmental conditions and trends, (8) the needs of the municipality including human resources, education, health, housing, recreation, social services, public utilities, public protection, transportation and circulation and cultural and interpersonal communications, (9) the objectives of energy-efficient patterns of development, the use of solar and other renewable forms of energy and energy conservation, (10) protection and preservation of agriculture, and (11) sea level change scenarios published by the National Oceanic and Atmospheric Administration in Technical Report OAR CPO-1.

POCDs are based on data, planning analysis, and community and institutional knowledge to identify goals and convey broad ideas about future development, conservation efforts, and other priorities for improving the community over the course of a decade. POCDs are policy documents intended to direct both public and private development and act as a guide to both short- and long-term decision-making, but are not regulatory in nature. A current POCD acts a guide for making suitable investments and implementing appropriate regulatory solutions to municipal challenges.

WP2-1.2. Municipal Economic Development Planning

Municipalities are enabled to plan for economic development as part of the POCD insofar as the fact that POCDs must address areas for commercial development, infrastructure, etc. Municipalities are not required to develop stand-alone economic development plans, but many choose to do so.

Municipal Economic Development Plans set out a comprehensive analysis of economic development conditions in the municipality, and provide strategic direction for improving the community's economic future. Economic Development Plans address the community's competitive advantages and challenges, identify redevelopment priorities, and lay out strategies for building upon existing strengths and niches while diversifying the municipality's tax and employment base. The planning process also addresses opportunities for the municipality to benefit from regional trends, investments, and partnerships. These plans provide guidance and

coordination for the efforts of Town officials, economic development staff, and members of the business and development community.

A Comprehensive Economic Development Strategy (CEDS) can be developed regionally, and they are required to access federal economic development dollars. They generally identify and prioritize redevelopment and investment sites/areas in a region, and as such should be aligned with local POCDs.

WP2-1.3. Municipal Planning Efforts that Affect Water Management

POCDs directly address water through several discussions. At a minimum, water is addressed in the chapters that focus on natural resources and public utilities/infrastructure, although POCDs often differ in their organization. POCDs typically include a myriad of statements related to the following:

- Protection of wetlands and watercourses
- Protection of aquifers
- Protection of water quality
- Reduction of stormwater generation through Low Impact Development and other methods
- Consideration of flood hazards
- Consideration of coastal hazards (in coastal municipalities)
- Areas served by sanitary sewer and areas not served by sanitary sewer
- Areas served by public water systems and areas not served by public water systems
- Needs related to sanitary sewer service and/or public water service

Various legislative acts have encouraged water quality and quantity management in the development of local plans and regulations over the years. For example, Public Act 85-279 amended CGS 8-23 and CGS 22a-42 to require municipal planning and zoning commissions as well as inland wetland agencies to incorporate consideration of existing and potential surface and groundwater source protection in their local plans and regulations.

The goals, objectives, and actions listed in POCDs will sometimes lead to new ordinances and changes in local regulations (Subdivision, Zoning, and others). This is one of the most direct ways in which POCDs can affect water. POCDs can also lead to the formulation of other plans and the receipt of grants for studies and projects that could also affect water. CGS Section 8-2 states that zoning regulations should be adopted with "reasonable consideration for the protection of existing and potential public surface and ground drinking water supplies."

Some municipalities resist water and wastewater systems, or system expansions, because of the belief that they will enable development. For example, Old Saybrook is a municipality that decided against implementing centralized wastewater treatment because the town was concerned about the potential for intensive coastal development.

WP2-1.4. Municipal Land Use Approvals that Link to Water Management

DEEP provides a comprehensive description of land use approvals on its web site ("Who Regulates Land Use in Connecticut?") at http://www.ct.gov/deep/cwp/view.asp?a=2703&q=433388. In their review of land use and land development applications, the various commissions active in each municipality (Planning Commission, Zoning Commission, Planning and Zoning Commission, Conservation Commission, and Inland Wetland Commission) have unique roles in water management. Some of the key roles include the following:

- Applications to wetland agencies are reviewed for adverse impacts to wetlands and watercourses
- Zoning district changes and zoning text amendments are typically reviewed in light of the availability of sanitary sewers and/or public water service
- Subdivision proposals are reviewed in light of the availability of sanitary sewers and/or public water service vs. the use of septic systems and wells[48]
- The initial approvals for a site plan application typically require that a source of water has been identified (public water system or individual well) and that the sanitary needs for the property have been addressed (sanitary sewer system or subsurface sewage disposal system)
- Zoning district changes and zoning text amendments are typically reviewed in light of the proximity to flood hazard areas
- Subdivision proposals are reviewed in light of the proximity to watercourses and flood hazard areas
- Calculations related to stormwater management and drainage are reviewed
- Proposed developments in DEEP-delineated aquifer protection areas are reviewed for consistency with the local aquifer protection regulations
- Land use applicants and their agents must notify water utilities and DPH of applications for projects or developments that are proposed in public water supply watersheds or aquifer protection areas
- Proposed projects in the coastal management area reviewed for consistency with the state's coastal management policies and regulations

WP2-1.5. Water Management Programs that Link to Municipal Land Use Approvals

The many land use approvals described above have, as their companions, a web of water management programs that affect municipal land use decisions and management. For example:

[48] Public Act 08-184 resulted in a report that addresses concerns about the adequacy of private well supplies for subdivisions: http://www.ct.gov/dph/lib/dph/environmental_health/private_wells/pdf/recommend_to_cga_ensuring_adequacy_purity_of_new_pdww.pdf

- The Certificate of Public Convenience and Necessity for new public water systems (administered by DPH and PURA) is intricately linked to the local land use approvals that require proof of a viable water source
- The DEEP's aquifer protection program relies on local review of projects and administration of the municipality's aquifer protection regulations (specifically, the water utility delineates the Aquifer Protection Areas in accordance with the mapping regulations and the municipality must adopt the mapping and implement the land use restrictions at the local level)
- The National Flood Insurance Program (NFIP) specifically identifies the "community" (municipality) as the entity that enforces flood damage prevention regulations in the areas delineated by FEMA as special flood hazard areas
- DPH is entitled to provide comments to local land use commissions related to projects that are proposed in public water supply watersheds and public water supply aquifers, and the commissions must consider these comments in their review and approval of projects. These reviews occur after land use applicants and their agents directly notify water utilities and DPH of their application, as explained above.

The above list includes only a few notable examples. In fact, many of the programs described in Section 2.2.1 have resulted in some type of linkage to municipal land use decisions. Despite the strong home rule tendencies, the state's municipalities are closely connected to water management programs and decisions made at the state level.

It is easy to identify the top-down state water management programs that affect land use decisions at the local level, but it isn't always easy to see how local land use decisions have affected water management. While reviewing the many factors that must be considered to approve a subdivision or development project, local commissions and agencies aren't always able to foresee the long term consequences. For example, a subdivision may be approved with individual wells and septic systems, but 40 years later the area may need either a public water system or a sanitary sewer system to address water quality concerns that have slowly developed over time. Likewise, the subdivision approval may not have included consideration of changing precipitation patterns or intensities, and nuisance flooding could occur more frequently in the future. The result is that the state has been faced with the task of helping municipalities address water quantity and water quality problems that have come to light over the last few decades.

WP2-2. Regional Planning

WP2-2.1. Regional Plans of Conservation and Development

Connecticut's planning regions provide a geographic framework within which municipalities can jointly address common interests, and coordinate such interests with state plans and programs. Among these plans is the Regional Plan of Conservation and Development, which provides recommendations involving land use, housing, parks, recreational areas, and other matters of regional importance.

The Plan not only provides a regional vision for conservation and development, but also serves as the basis for the Councils of Government (COGs) to fulfill their roles of commenting on the

consistency of municipal Plans of Conservation and Development with regional and state-level plans and growth management principles.

The Connecticut General Statutes require Regional Planning Organizations (RPOs) to update their Plans of Conservation and Development at least once every 10 years. Because the state's RPOs were reorganized in 2013-2014, the status of the Regional Plans of Conservation and Development are in flux. Several RPOs were merged and two were dissolved, and all RPOs became COG. The number of RPOs changed from 15 to nine. Therefore, some of the existing Regional Plans of Conservation and Development are not coterminous with the COGs that inherited them. These inconsistencies will change over the next few years as new regional plans are developed.

WP2-2.2. Regional Planning Efforts that Affect Water Management

The COGs typically develop regional plans that fall into several categories:

- Conservation and development
- Transportation
- Emergency planning, hazard mitigation, and emergency response
- Special committees
- Special projects

The Regional Plans of Conservation and Development often serve as the filter between local POCDs and the State Conservation and Development Policies Plan (described below) and therefore the regional plans have the ability to affect long-term development which is closely tied to water as noted above. The COG transportation planning efforts have significant potential to affect water directly (e.g., through roadway widening near watercourses) or indirectly (e.g., by changing traffic patterns which can affect economic development). The emergency planning and hazard mitigation planning efforts are typically focused on flooding and flood management (e.g., through multi-jurisdiction hazard mitigation plans) as well as other facets of emergency planning that are not related to water.

The COGs can form subcommittees to address water issues of interest. For example, the Southeastern Connecticut Council of Governments (SCCOG) has organized a subcommittee to address long-term water supply issues and challenges in southeastern Connecticut. The subcommittee has divided the region into three sub-regions (northern, southwest, and southeast) and has identified a number of projects in each of the three sub-regions that can strengthen the entire southeastern Connecticut region.

And finally, many of the special projects coordinated by the COGs could be related to water. For example, two COGs (WestCOG and SCCOG) secured grants to identify methods of helping their members municipalities join the FEMA Community Rating System (CRS) program to promote flood mitigation and reduce flood insurance premiums.

Aside from their planning functions, the COGs have one special role related to water management. By state statute, each COG is a member of a water utility coordinating committee (WUCC) and

therefore has been granted a direct hand in developing the state's three coordinated water system plans. Subsequent to developing the coordinated water system plans, the COGs will continue as WUCC members and will be able to help make additional decisions relative to public water services throughout the state.

As noted in Section 1.2, A CEDS can be developed regionally. These are sometimes developed by COGs in Connecticut. A CEDS is required to access federal economic development dollars. They generally identify and prioritize redevelopment and investment sites/areas in a region, and as such should be aligned with local POCDs. As such, a CEDS could affect water in the same ways described throughout this paper.

WP2-3. State Planning

WP2-3.1. State Conservation and Development Policies Plan

The Conservation and Development Policies Plan is developed and updated on a five-year revision cycle by the Office of Policy and Management and adopted by Connecticut's General Assembly under the provisions of Chapter 297, Section 16a-24 to 16a-33 of the Connecticut General Statutes. The current Plan was Adopted by the Connecticut General Assembly on June 5, 2013, and includes six Growth Management Principles that lay out major priorities for guiding conservation and development across the state, as well as policy statements that provide a basis for state agencies to assess the consistency of their proposed plans and actions with the State Plan:

1. Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure;
2. Expand Housing Opportunities and Design Choices to Accommodate a Variety of Household Types and Needs;
3. Concentrate Development Around Transportation Nodes and Along Major Transportation Corridors to Support the Viability of Transportation Options;
4. Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands;
5. Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety; and
6. Promote Integrated Planning Across all Levels of Government to Address Issues on a Statewide, Regional and Local Basis

These Principles, as well as a Locational Guide Map included in the Plan, are intended to guide actions by state agencies, particularly those involving major property acquisitions or development or state grants for development projects. The Plan also serves an advisory role for municipal plans, regulations, and land use decisions; and is a central focus of Environmental Impact Evaluations EIEs) conducted under the Connecticut Environmental Policy Acts (CEPA).

WP2-3.2. Economic Development Planning

Connecticut's economic development planning is conducted by the State Department of Economic and Community Development (DECD) through the State's Economic Development Strategy. The Plan is updated annually and examines a variety of indicators and addresses the outlook for statewide economic development, examining strengths, weaknesses, opportunities, and threats to economic growth. It identifies existing business clusters that drive Connecticut's growth, high-priority sectors for targeted efforts to attract additional investment, and key priorities for attracting and retaining talent in the state. The planning process results in strategies for statewide agencies to support business recruitment, branding, education, workforce development, entrepreneurship, and local livability.

The Economic Development Strategy (2015) targets "priority investment areas including healthcare/ bioscience, insurance and financial services, advanced manufacturing, digital media, tourism, and green technologies, with attention to how these sectors collaborate and intersect." Within these targeted industries are "more specialized areas that show promise for the Connecticut economy including biomedical devices, aircraft manufacturing, and boat building." The four objectives of the plan (and its sub-objectives) are:

- Grow the Business Clusters that Drive Connecticut's Economy and Encourage Entrepreneurial Development
  - Retain and grow existing job base
  - Facilitate ecosystems for industries to strengthen, connect, and collaborate
  - Support entrepreneurial activities
  - Build exports and encourage foreign direct investment
  - Promote Connecticut's brand effectively nationally and international
- Ensure a Workforce that Meets the Needs of the Future
  - Understand the future needs of employers
  - With education partners, grow and enrich our talent pool and develop both short and long range initiatives to invest in our institutions around the key STEAM (science, technology, engineering, arts, and mathematics) skills
- Create Livable, Vibrant Communities
  - Create vibrant neighborhoods through innovation, art, culture, and historic preservation
  - Ensure quality housing at a broad range of prices
- Invest in Infrastructure and Support Systems that will Foster Business Growth
  - Continue to strategically invest in transportation infrastructure
  - Work to reduce or offset the cost of energy while reducing greenhouse gas emissions
  - Continue efforts to create a more responsive government that reforms the regulatory environment and makes it easier to do business in the state

- Encourage environmentally-friendly, modern, and resilient development

WP2-3.3. Population Projection Data Sets

Statewide Population Projections are prepared and updated by two major entities – the Connecticut State Data Center at the University of Connecticut, and the Connecticut Department of Transportation:

- The State Data Center is the state's lead agency in the U.S. Census Bureau's State Data Center Program that makes data available locally to the public through a network of state agencies, universities, libraries, and regional and local governments. As part of this mission, the State Data Center provides population projections to assist state agencies, non-profit organizations, businesses, governments, and centers/organizations to identify potential population changes into the future. These projections are based on several datasets, including state and locally derived fertility rates. The State Data Center's current projections are available in five-year increments for 2015-2025.
- The Department of Transportation projects statewide and local population as an input into statewide long-range transportation planning and modeling efforts. Current projections are prepared based on data from the 2010 Decennial Census by the Office of Coordination, Modeling, and Crash Data's Bureau of Policy and Planning. The Department of Transportation's projections are available in ten-year increments for 2020-2040.

When the DOT projections are compared to those prepared by the Connecticut State Data Center (CTSDC), some discrepancies are noted. For instance, the CTSDC population projections show more modest growth rates compared to the DOT projections. While the DOT projections show continued population growth across all municipalities, the CTSDC projections show many rural and suburban towns losing population up to 2025. When the DOT projections and the CTSDC projections are compiled by classification (rural, suburban, and urban), similar trends emerge. The urban, suburban, and rural population projections are slightly lower for the CTSDC projections through 2025 than for the DOT projections.

The State Water Plan Policy Group has promoted use of the State Data Center projections. The Water Supply Assessments prepared in September 2016 pursuant to the WUCC process have presented and described both sets of population projections, deferring the selection of projections to a later phase of the WUCC process. The CTSDC reports that its population projections will likely be updated by the spring of 2017 such that they will be available for additional planning.

WP2-3.4. Climate Change Preparedness Plan

Public Act No. 08-98, An Act Concerning Connecticut Global Warming Solutions, required the Governor's Steering Committee on Climate Change to establish an Adaptation Subcommittee to evaluate the projected impacts of climate change on Connecticut's agriculture, infrastructure, natural resources and public health; and develop strategies to mitigate these impacts. The Adaptation Subcommittee detailed the projected impacts of climate change in a 2010 report, "The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health." The second report prepared pursuant to the Act is the Connecticut Climate Change Preparedness Plan (2011).

A list of adaptation strategies is provided in the Connecticut Climate Change Preparedness Plan. Perhaps not surprisingly, more than half of the many actions in the plan are related to water:

- Encourage development practices that ensure water recharge
- Encourage sustainable water capture and storage by homeowners, municipalities, businesses, and industries, and the agriculture sector with incentive programs to supplement capture and storage infrastructure
- Develop water reuse guidelines for industry
- Encourage adaptation strategies, including natural habitat conservation, Low Impact Development (LID) Best Management Practices (BMPs), agriculture water BMPs and drinking water treatment standards that will ameliorate the effects of water inundation
- Minimize water use across all agricultural sectors
- Assess current and future needs for potable water uses and to plan for infrastructure improvements to the public water system
- Assess future needs for non-potable water uses
- Assess future flooding risks to natural and built infrastructure, including agricultural operations and public health and safety
- Analyze the competing demands on Connecticut water quantity and quality statewide in a consistent and comprehensive manner and develop new approaches to ensure public health, agricultural sustainability, ecosystem health, while supporting multiple and conflicting needs
- Target water conservation education towards specific consumer groups
- Assess the impact of climate change on wastewater treatment facilities, and encourage the development of facility-specific adaptation plans
- Determine the critical public buildings, including public health facilities, schools and cultural/historic buildings that will be impacted by coastal and inland flooding, and recommend appropriate adaptation strategies that will not adversely impact natural resources
- Perform a comprehensive modeling assessment of the extent of inland migration of tidal marshes essential for directing adaptation actions
- Broaden water use planning to include climate change projections
- Adopt a water hierarchy that includes water conservation, capture and storage and water reuse, similar to the well-known solid waste management “reduce, reuse and recycle” hierarchy
- Target headwaters for protection throughout the state
- Implement rate structures to accommodate long term system improvements and encourage conservation

- Examine opportunities for water conservation strategies within the building code, in appliance standards and in regulatory decisions
- Minimize combined sewer overflows
- Acquire land and conservation easements to provide upslope advancement zones adjacent to tidal marshes
- Acquire land and conservation easements in riparian areas adjacent to coldwater streams
- Apply climate change projections to future stream flow regulations
- Continue to support funding to provide for adequate updates to municipal sewage infrastructure.
- Support funding to provide for adequate updates to municipal water infrastructure

WP2-3.5. State Green Plan

Recognizing the threat of loss of environmental resources to changes in land use, the General Assembly set a goal of protecting 21% of Connecticut's land by 2023 for public open space. With a total of 3,205,760 acres in the state, 673,210 acres must be protected to meet this goal. Section 23-8b of the general statutes set open space acquisition targets for both the state and its land protection partners (municipalities, private non-profit land conservation organizations, and water utilities):

- 10% (or 320,576 acres) is to be acquired and held by the State of Connecticut Department of Energy and Environmental Protection (DEEP)
- 11% (or 352,634 acres) is to be acquired and held by DEEP's land conservation partners

As of early 2017, and based on best available data, an estimated 505,015 acres were held as public open space in Connecticut, or 75% of the total statutory open space goal.

Connecticut's 2016-2020 Comprehensive Open Space Acquisition Strategy (Green Plan, updated from previous updates of the 2001-original Green Plan) serves as a statewide planning document developed by DEEP in partnership with municipalities and numerous conservation organizations to guide land acquisitions through towards achieving the open space goal. Integral to the current Green Plan is a five-year action strategy with acquisition priorities and targeted acreages to protect specific lands identified as capable of providing certain benefits – such as buffers to climate change, critical habitats, and recreational trails. As such, it provides specific guidance for program managers, is a tool for those who want to work with the state in preserving land, and offers a basic overview for the public of the state's land acquisition and protection programs.

The Green Plan's recommendations for the acquisition of lands for environmental and public use and benefit center around four major themes:

- Natural Waters and Drinking Water Resources;
- Areas Significant to the Coast;
- Natural Heritage Resources; and

- Natural Resource-based Outdoor Recreation.

In particular, the Green Plan "gives priority to the acquisition of lands that serve to protect high-quality natural waters and drinking water resources. Clean water, including in our rivers, lakes, and inland wetlands, are essential to life and provide some of the richest wildlife habitat in the state. Land conservation is an important part of watershed management for protecting habitat and water quality against impacts by fragmentation, climate change, runoff pollution, and other threats."

The plan's open space acquisition priorities were developed in coordination with and support of other key State planning documents related to open space, such as the Climate Change Preparedness Plan, Forestry Action Plan, Wildlife Action Plan, and Comprehensive Outdoor Recreation Plan. In addition, a series of meetings and discussions were held with internal and external conservation partners. DPH provided comments to DEEP relative to this plan update, articulating the desire that public water supply watersheds, aquifer protection areas, and the role of water utilities as open space stewards be emphasized.

The Green Plan can be accessed in sections or in its entirety at DEEP's webpage: www.ct.gov/deep/greenplan.

WP2-3.6. Open Space and Land Acquisitions Grant Programs

The DEEP Open Space and Watershed Land Acquisitions Grant Program provides financial assistance to municipalities and non-profit land conservation organizations to acquire land for public open space purposes and to water utilities to acquire land that can be classified as Class I or Class II water supply property. Since the program's inception in 1998, $125.5 million in grants has supported the acquisition of over 500 properties totaling over 33,000 acres in 127 municipalities.

In accordance with CGS Section 7-131d (b), grants under this program are for land purchases that meet one or more of the following criteria:

- Protects land identified as being especially valuable for recreation, forestry, and fishing, conservation of wildlife or natural resources;
- Protects land which includes or contributes to a prime natural feature of the state's landscape, including, but not limited to, a shoreline, a river, its tributaries and watershed, an aquifer, mountainous territory, ridgelines, an inland or coastal wetland, a significant littoral or estuarine or aquatic site or other important geological feature;
- Protects habitat for native plant or animal species listed as threatened or endangered or of special concern, as defined in section 26-304;
- Protects a relatively undisturbed outstanding example of a native ecological community which is now uncommon;
- Enhances and conserves water quality of the state's lakes, rivers and coastal water;
- Preserves local agricultural heritage; or

- In the case of grants to water companies, protects land which is eligible to be classified as Class I land or Class II land after acquisition.

Conditions that apply to these grants include:

- The acquired land must be protected by a permanent conservation and public recreation easement requiring that the property remain forever predominately in its natural and open condition;
- Any improvements or change to the property must support the purpose for which the land was acquired; and
- The conservation and public recreation easement includes a provision that the property be made available to the general public for passive recreational purposes.

DEEP evaluates proposals for Open Space and Watershed Land Acquisition grants on an annual basis. Applications were most recently due in February 2017.

The DEEP Recreation and Natural Heritage Trust Program was created by the state legislature in 1986 in order to help preserve Connecticut's natural heritage. It is DEEP's primary vehicle for acquiring land to expand the State's system of parks, forests, wildlife management and water access areas, and other natural open spaces. DEEP manages the acquisition of land of statewide significance that represent the ecological diversity of Connecticut, including natural features such as rivers, mountains, coastal systems, and other natural areas, in order to ensure the preservation and conservation of such land for recreational, scientific, educational, cultural, and aesthetic purposes.

As parcels of land are made available by willing sellers, DEEP assesses their compatibility with the framework and priorities established in the Green Plan. Further, a property acquired under the Recreation and Natural Heritage Trust Program should possess one or more of the following attributes:

- High value for passive outdoor recreation, forestry, or wildlife resource conservation, especially if it is near a population center;
- A prime, natural feature of the landscape, such as a major river, its tributaries and watershed;
- Habitat for native plant or animal species listed as threatened or endangered or of special concern;
- A relatively undisturbed outstanding example of a native ecological community which is now uncommon; or
- Is threatened with conversion to incompatible uses or contains sacred sites or archaeological sites of state or national importance.

A statutory provision of the Recreation and Natural Heritage Trust Program allows DEEP to reduce open space acquisition expenses by entering into agreements with partner cooperators,

including municipalities, non-profit land conservation organizations, utility companies, and federal and other State agencies. Designed to stretch State funding for new acquisitions and reduce stewardship costs, this "cooperators provision" offers a mutual benefit between the State and one or more of its land conservation partners when the State and a partner have a common desire to protect a certain property but either may not have the resources available to do so. The responsibility for managing properties acquired in this manner is negotiated between DEEP and the contributing partner(s) involved in the transaction, however, the property is owned by the State. In the case of land donations to the State, a cooperator may steward the property while the State maintains ownership. As an example, the Town of Columbia and DEEP jointly manage Mono Pond under a stewardship agreement for natural resource conservation and public passive recreation.

More on DEEP's open space programs, including annual acquisitions reporting, can be accessed at its webpage: www.ct.gov/deep/openspace.

WP2-3.7. State Planning Efforts that Affect Water Management

The State's Conservation and Development Policies Plan has a direct impact on water management in Connecticut. For example, numerous state-funded or state-assisted actions such as the extension of sanitary sewers or water mains cannot proceed if the action is inconsistent with the Conservation and Development Policies Plan and its maps. Where inconsistencies are noted, the CEPA process allows for the completion of an EIE and identification of mitigation actions that can be used to make the action possible. Nevertheless, the Conservation and Development Policies Plan creates a barrier to some actions.

To the extent that the Connecticut Green Plan leads to key land acquisitions for open space, it too can affect water management. The setting aside of lands to remain as open space will benefit water quality in the watersheds as the lands are acquired, and will tend to eliminate or minimize the need for public water supply in those areas.

The Economic Development Strategy sets policies and objectives for spurring employment growth through existing businesses and industries as well as others that are desired. The availability of water supply will be critical for many of these businesses, as will the availability of systems to handle and treat wastewater.

The Connecticut Climate Change Preparedness Plan may lead to changes in how the state manages water. The numerous action items of the plan will need to be implemented by different agencies and departments.

Other statewide plans that are not described in this paper have the potential to affect water management. Consider the following:

- The Connecticut Natural Hazard Mitigation Plan (2014) [identified in Section 2.2.1] sets policies and identifies actions to reduce the cycle of flood damage that occurs in the state each year. The plan describes the state's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis, and furthers shifts the state from a disaster-response driven system to one based on effective hazard mitigation planning. The plan also references the additional challenges that climate change poses to the state.

- The Drought Preparedness and Response Plan (2016, draft) [discussed in detail in Section 2.2.1] describes drought responses that can be adopted by municipalities and long term preparations to consider such as structural (other than short-term behavior) changes to consider.
- The State's Comprehensive Energy Strategy (2013) [discussed in detail in Section 2.2.1] offers recommendations in five major priority areas: energy efficiency, industrial energy needs, electricity supply including renewable power, natural gas, and transportation. Water conservation is a major recommendation of the plan.
- The State's "Blue Plan" [identified in Section 2.2.1] will include an inventory of Long Island Sound's natural resources and uses and offer a spatial plan to guide future use of the Sound's waters and submerged lands.
- The Statewide Comprehensive Outdoor Recreation Plan identifies outdoor recreation issues of statewide significance and evaluates the supply of and the demand for outdoor recreation resources and facilities, which may include water-based recreation. The plan provides unified guidance to state and municipal officials as they develop and expand outdoor recreation opportunities.

WP2-3.8. State Land Use Approvals that Link to Water Management

Due to Connecticut's home rule policies, municipal agencies are responsible for the vast majority of land use approvals in the state. These were discussed earlier in this paper. However, there are a handful of state land use approvals that are necessary for certain development proposals, and some of these directly link to water management. Consider the following:

- The Connecticut Siting Council is responsible for the siting of electric transmission lines and electric substations with a design capacity of 69-kilovolts or more, electric generating and storage facilities, telecommunications facilities, and hazardous waste facilities. One key consideration in the siting of generating facilities is the availability of water.
- The DEEP's Flood Management Certificate is a permit that must be sought and obtained for state-funded actions (including partial funding and federal funds that are administered by the state). Examples include site developments, construction projects, infrastructure projects, etc. The certificate can only be issued if the proposed action does not increase the potential for flood damage through changes in runoff and drainage, filling in a floodplain, etc.
- The DEEP's Inland Wetland and Watercourses permit regulates activities undertaken by state agencies in or affecting inland wetlands or watercourses.
- The DEEP's coastal site plan review process occurs in parallel with the municipality's coastal site plan review process for development projects proposed in the coastal management area. Proposals can only be approved if impacts to water quality and minimal and coastal hazards are not worsened.
- The Certificate of Public Convenience and Necessity is a three-part process administered by DPH and PURA to approve of a new public water system and its components. Through the

certificate process, DPH reviews and approves various aspects of the development proposals that resulted in the need for a new public water system.

- Outside the Certificate of Public Convenience and Necessity, DPH has the authority to review and approve new well sites, treatment facilities, storage facilities, and other water works that may accompany land use proposals.

Other programs have an important role in siting decisions, although they may not be formal land use approval processes. For example, the State's Water Quality Standards have a role in siting decisions such as landfills, and in how brownfields are addressed. The standards also restrict the types of discharges that can occur to ground and surface waters. The Aquifer Protection Program prohibits siting of land use activities that use hazardous material in the delineated protection areas.

WP2-3.9. Water Management Programs that Link to State Land Use Approvals

Earlier in this paper, we noted that many of the state programs described in Section 2.2.1 have resulted in some type of linkage to municipal land use review and approvals. This is true for state land use approvals as well, except that there simply are not as many state land use approvals as there are local land use approvals in Connecticut. The land use permits listed above (siting council, flood management certificate, inland wetlands and watercourses permits for state actions, etc.) are inherently linked to water management programs described in Section 2.2.1. For example, the flood management certificate is based on consistency with the NFIP and flood management principles whereas the State's Inland Wetland and Watercourses Permit (for state actions) is similar to a municipality's Inland Wetland and Watercourses regulations and permitting process.

WP2-4. How Land Development is Trending

The Preliminary Water Supply Assessment for each of the three public water supply management areas (PWSMAs) – West, Central, and East – was prepared in September 2016. Chapter 5 of each assessment report contains a detailed discussion of land use, zoning, population, population projections, and building permit trends for the region. The details are best left to the Preliminary Water Supply Assessment reports, but some of the key findings are listed below by region:

- The Western Connecticut PWSMA contains a great diversity of municipalities, including some of the state's largest cities and smallest rural towns. Population projections indicate that the region will continue to see modest population growth over the next several decades. However, that population growth will be unequal. In particular, Stamford and Danbury are projected to continue to see rapid growth up to 2040. On the contrary, rural communities in Litchfield County are projected to see slower population growth. When investigating housing data over the last twenty years, several interesting trends emerge. The most notable is the unequal recovery in the housing market since the late 2000s recession. Suburban and rural communities continue to see stagnant new home construction. While the pace of construction has increased slowly over the last few years, it is still occurring at a much slower pace than they did in the late 1990s and early 2000s. On the contrary, urban areas are experiencing a building boom and have exceeded their pre-recession pace of home construction. This is being driven by large residential construction

projects in Fairfield County, notably in Stamford, Norwalk, Danbury, Shelton, and Bridgeport. Most of the development in these communities is infill development or the redevelopment of underutilized properties. If the pace of economic growth in Fairfield County continues, it is likely that this rapid pace of development will continue over the coming years.

- The Central Connecticut PWSMA contains two of the state's largest cities and many of its largest suburban towns. The population projections indicate that urban municipalities will continue to see population growth over the next 25 years. Recent growth in the core cities of Hartford and New Haven are projected to continue at a modest pace. Continuing the trends of the last 50 years, suburban communities are expected to grow at a moderate rate, adding 125,000 new residents by 2040. However, within suburban communities, growth rates are uneven. Suburban communities with developable land located on the urban periphery are projected to experience the highest growth rates. Municipalities in the Central PWSMA are largely residentially zoned with varying levels of potential buildout possible. Housing data shows a slow but steady recovery in the regional housing market in the years following the recession of 2008-2009. Urban communities in general have recovered at a faster pace than suburban communities. A handful of municipalities such as Milford, New Haven, West Hartford, and Vernon have exceeded their pre-recession permitting activity in 2015. Based on recent data, it is anticipated that in the short term, new home construction will be concentrated in a small number municipalities and will be primarily consist of multi-family housing developments.

- The Eastern PWSMA is the least urban of the three Connecticut PWSMA areas. Population projections show that the urban municipalities are forecast to grow slowly in the coming decades. Rural municipalities are also expected to continue slow, steady growth. The suburban communities will gain continuously throughout this period. Due to the recession of 2008-2009, housing construction has slowed considerably, especially within the rural areas. In recent years, the suburban municipalities have been accumulating the most new homes. Due to the cyclic nature of the housing market, it is likely that the most future growth in this region will continue to occur in the suburban areas. However, the three urban municipalities (Norwich, New London, and Groton) as a group fared comparatively well and should be watched for signs of potential greater growth.

Section 3

Preparing for Change: Future Conditions and Opportunities

The evaluation of future conditions attempts to answer the question "Will Connecticut still have enough water approximately 20 years from now to still meet most needs and at most times?" From 2010 to 2040 the Connecticut State Data Center (SDC) projects only a 3.6% statewide growth, with 57% of towns gaining population, and 43% losing population. Generally, while there still should be sufficient drinking water in the state between now and 2040, there may be conditions that make it more difficult for a basin to satisfy all out-of-stream and instream needs. When instream uses are fully considered following the phased implementation of the CT Stream Flow Standards and Regulations, more gaps become apparent, especially in the summer months. The potential for reduced water availability during certain times of the year and at select locations further emphasizes the need for detailed evaluations of specific utilities or water systems in order to prevent shortages through conservation, interconnections, alternative supplies or other measures.

An analysis of potential impacts due to climate change suggests that future climate trends throughout the state are likely to lead to higher risks of flooding during the winter months, and potentially lower streamflows during summer months. The potential departure from historic norms is likely to be more significant with respect to flood risk – that is, flows are likely to increase in the winter by a higher percentage than that by which they would decrease during the summer (and under certain conditions, summer flows may not actually decrease). Although the analysis did not evaluate the potential frequency of droughts, the lower flow projections in the summer suggest more frequent occurrences of short-term seasonal droughts, which could increase risks of many basins in Connecticut that rely on small drainage areas with less than 2 or 3 months of storage capacity in reservoirs.

An analysis of water use patterns and demographics in each basin suggest that long-term adaptations in residential and commercial water use coupled with drought response cutbacks could produce conservation levels that are not insignificant (on the order of 10-20%). The analysis did not specifically address improvements in industrial or agricultural water use efficiency. However, the analysis did not distinguish future conservation potential from conservation already attributable to progressive initiatives sponsored by individual water utilities and to long-term passive conservation (expected to continue) yielding significant reductions in water use owing to plumbing codes, fixture replacement, etc. It is recommended that further study for each water system be conducted to determine upper bounds on conservation expectations, both long term and during droughts. Regardless of the quantitative impact on risk reduction, the Plan strongly advocates for enhanced conservation throughout the state to help guard against future uncertainties in climate, economic growth, and regulatory conditions.

Included at the end of this section are two white papers that describe opportunities and challenges for managing water in the future. These papers are not intended to convey positions, priorities, values, or recommendations. Rather, they are factual documents reviewed by the four state agencies with purview over water (DEEP, DPH, OPM, and PURA), as well as the Water Planning Council and its supporting sub-committees and advisory groups.

The first white paper (section 3.2.1) examines future water management options. This paper outlines the broad strategies that may be used to address Connecticut's water needs – ***the "Options" for future water management***. Both demand management options, such as water conservation and changes in development patterns, and supply management options, such as use of Class B water for non-potable uses and water reclamation/reuse are discussed.

The second white paper (Section 3.2.2) examines future water management challenges. The purpose of this paper is to identify and describe some of the conditions within the State of Connecticut that will likely pose challenges to meeting the objectives of the State Water Plan with the available water management options and opportunities described the other white papers. The paper is not a critique of the future challenges, but an effort to broaden awareness of both the benefits and the potential hardships associated with current and past conditions. With this framework as its basis, the paper addresses a number of future challenges to the implementation of water management opportunities including, but not limited to data gaps, funding constraints, the prohibition of Class B waters for human consumption, water system vulnerabilities and aging infrastructure.

3.1 Future Technical Assessment

3.1.1 Future Water Demands

To understand if and where potential gaps between water availability and demand may exist as a result of population growth and the phased implementation of the CT Stream Flow Standards and Regulations, estimates of future water demand have been prepared for the year 2040. The approach to developing estimates for future out-of-stream water demands is discussed first followed by a summary of the ongoing implementation of the CT Stream Flow Standards and Regulations (instream demands).

3.1.1.1 Future Out-of-Stream Demands

Out-of-stream water demands include any water use that requires the removal of water from a stream or aquifer, even if some or all of it is returned at a downstream location. Out-of-stream demands are associated with public water systems, residential private wells, and non-residential, non-public water systems (e.g., industry, commercial, agriculture, etc.).

The State Water Plan Policy Subcommittee directed that the Plan should use the State Data Center (SDC) population projections to estimate future water demand. The SDC projections assume generally lower growth rates compared to projections developed by the DOT. SDC projections developed in 2012 for year 2040 were used to coordinate with the selected future planning horizon. The SDC population projections result in a 3.6% statewide growth from 2010 to 2040, with 57% of towns gaining population, and 43% losing population.

In order to develop future water demands for each utility using town-based population projections, a ratio of future to current population growth of towns served by the utility was developed for the large public water systems (those that serve over 1,000 individuals). The ratio for each utility was then applied to the demand from that utility in each regional basin.

Small community systems serving a population less than 500 people were held constant. Many small systems serve a condo complex, school, or built-out residential community. It is unlikely that many of these systems have the capacity or the desire to expand, and thus it would be impractical to provide individualized projections for a demand that is unlikely to change significantly.

Future demand from small community systems serving greater than 500 people was adjusted according to the individual town 2010 to 2040 growth rate ratios. Unlike with large community systems, this method is useful in this application, as many "large" small community systems are small municipal or privately owned systems that are localized to one town, and have the possibility of future expansion within that town.

Future demand from private (domestic) wells was estimated using the average 2010 to 2040 growth ratio of all community water systems within the same regional basin serving a population greater than 500 people.

On a per capita basis, water use in 2040 was assumed to remain the same as today. Per-capita water use has generally trended downward over the last several decades due to numerous factors such as more efficient residential appliances and fixtures. If the trend of declining per-capita water use continues, the demand estimates presented here may overstate actual future demand, assuming all other factors are accurately predicted.

Demands for commercial, industrial and agricultural uses were held constant. Similar to the declines in per capita demand for the residential sector, more efficient water use and reuse practices have continued to reduce demand in these sectors. Continued reductions in demand are generally assumed to offset demands from growth. According to Census of Agriculture data, the amount of irrigated land statewide has actually declined from 10,139 acres in 2002 to 9,272 acres in 2012. No increase in irrigated acres was assumed for 2040, and the ratio of groundwater to surface water demand was assumed to remain constant.

Based on projected population changes, year 2040 statewide total water demand for out-of-stream use is estimated to increase by just under 3%, from approximately 444 to 456 mgd. Surface water demand is estimated to increase from approximately 355 to 368 mgd. Net groundwater demand is estimated to decrease slightly, from 89 to 88 mgd.

3.1.1.2 Future Instream Needs

Instream needs refer to water that must remain in place to serve ecological, recreational or aesthetic purposes. The state's Stream Flow Standards and Regulations were updated in 2011 to include required releases at certain dams to help provide flows for ecological purposes while still providing for out-of-stream demands, flood control, and other lawful uses of water. The required releases may be reduced during drought or when the releases compromise the ability of a public water system to meet existing demand. However, it is acknowledged that these flows alone do

not constitute the full ecological water needs of a given basin, nor do they necessarily provide flow for recreational or aesthetic needs. Total in-instream flow needs, which include estimated ecological needs, were discussed in Section 2.1.4.3. For the purposes of this Plan, they are based on Q50 flows for average annual conditions, and Q50 to Q80 flows for July through October, as calculated by the Connecticut StreamStats program.

The stream flow standards are established uniquely for four different classes of waters. Class 1 waters are free flowing and priority is given to protecting ecological health. Class 2 and 3 waters are characterized by minimally to moderately altered flow and have intermediate balance points between ecological human uses. Class 4 waters are substantially altered and support of human activities is weighted most heavily. The flow standards for each class are based on maintaining, to various degrees, the natural variation in flow expected in Connecticut given seasonal climate and rainfall patterns.

The process of classifying the streams and rivers of the state and establishing minimum flows is ongoing. Stream flow classifications were finalized in the Southeast Coastal, Pawcatuck and Thames Major basins in October 2014. In September 2016, final stream flow classifications for the South Central Coastal River Basin were established. Stream flow classifications for the western portion of the state are still in development.

Dam owners or operators that impound or divert the waters of a river or stream or that affect the flow of water in such a system will be required to comply with the stream flow regulations and make certain minimum releases which vary based on the stream classification. Class 1 streams are free flowing and must be maintained that way. Minimum releases on Class 2 streams must result in 75% of natural inflow being maintained. Class 3 streams require the most balancing of human and ecological needs and as such, have a more detailed set of minimum releases. In the context of the State Water Plan, the minimum releases are considered to be future instream (or non-consumptive) demands, given the phased implementation of the CT Stream Flow Standards and Regulations.

The minimum releases of reservoirs on Class 3 streams are set differently, depending on the bioperiod. A bioperiod is a specific time period during the course of the year when certain biological processes occur that depend on the seasonal variability of stream flow rates, such as spawning and rearing and growth. Small reservoirs, reservoirs in series, and reservoirs in small watersheds on Class 3 streams are subject to a single minimum release (Minimum Release Rule) throughout the year, or natural flow, whichever is less. These are referred to as RGQ80 reservoirs, as they are required to make minimum releases that correspond to the Rearing and Growth bioperiod of July 1 through October 31 for antecedent dry conditions. The 32 reservoirs which are anticipated to be subject to the Minimum Release Rule are listed in **Table 3-1** along with their minimum flow requirement. The CT Stream Flow Standards and Regulations are as calculated by the USGS StreamStats program.

Table 3-1. Preliminary Estimate of Minimum Required Releases (in cfs) for Minimum Release Rule Reservoirs

Regional Basin ID	Reservior Name	Bioperiod / Effective Date / Percentile / System	Notes	Rearing and Growth - Dry July 1 - Oct 31 Q80
Rearing and Growth Q80 (RGQ80)				
72	Aspetuck Reservoir	Hemlocks	2	2.20
60	Means Brook Reservoir	Trap Falls	2	1.04
60	Far Mill Reservoir	Trap Falls	2	0.87
43	Bristol Reservoir #3	Bristol	2	0.61
74	Putnam Lake Reservoir	Rockwood	1,3	0.18
21	Palmer Reservoir	Pamer/Dean	2	0.67
21	Dean's Mill Reservoir	Pamer/Dean	2	0.59
31	Stafford Reservoir No. 2	Stafford	2	0.37
31	Stafford Reservoir No. 3	Stafford	2	0.25
51	KelseyTown Reservoir	Guilford	2	1.13
40	Wilcox Reservoir	Chester	2	0.41
40	Deuses Pond	Chester	2	0.44
69	Straitsville Reservoir	Naugatuck Central	1,2,3	0.14
30	Billings Avery Brook Diversion	Groton	1,2,3	0.14
21	Morgan Pond Reservoir	Groton	4	0.49
21	Poheganut Reservoir	Groton	1,3	0.18
21	Smith Lake	Groton	1,2	0.27
45	Lydall Reservoir No.2	Manchester	1,2	0.33
45	Lydall Reservoir No.1	Manchester	1,2	0.34
45	Globe Hollow Reservoir	Manchester	1	0.46
46	Kenmere Reservoir	Kenmere	2	0.50
43	Whigville Reservoir	Shuttle Meadow	2	0.62
52	Wolcott Reservoir	Shuttle Meadow	1,3	0.18
46	North Hart Pond	Shuttle Meadow	1	0.27
46	South Hart Pond	Shuttle Meadow	1,2	0.23
22	Lake Konomoc Reservoir	Lake Konomoc	1	0.25
22	Barnes Reservoir	Lake Konomoc	1	0.21
22	Bogue Brook Reservoir	Lake Konomoc	1,3	0.18
22	Beckwith Pond Diversion	Lake Konomoc	2	0.88
73	John D. Milne Reservoir	Grupes	4	0.86
73	Browns Reservoir	Grupes	4	0.71
30	Stony Brook Reservoir	Stony Brook	1,3	0.11
53	Lake Bethany	West River	4	0.45
53	Lake Watrous	West River	4	0.79
53	Lake Chamberlain	West River	3,4	0.12
53	Lake Glen	West River	3,4	0.18
69	Morris Reservoir	Wigwam		0.28

Notes - Special provisions may exist for:

1 - Drainage is less than 3 sq. miles *2 - Reservoir has 100 MG or less usable storage*

3 - RGQ is between 0.1 and 0.2 cfs for public water supply

4 - Stream segments 1.5 miles or less between impoundments

Source: CT DEEP

Data presented are only estimated releases based on limited information on reservoirs; actual release volumes will depend on additional reservoir-specific data.

Large reservoirs are subject to the Multi-Level Release Rule (MLRR), which specify a set of minimum releases for six different bioperiods, as well as two different minimum releases for the Rearing and Growth bioperiod, depending on antecedent wet or dry conditions. These flows are aimed at mimicking natural flow variations and river processes that support aquatic life. The 23 reservoirs which are anticipated to be subject to the MLRR are listed in **Table 3-2** along with their estimated minimum flow requirements for each bioperiod. Note that the minimum flow requirements presented here are as calculated by USGS Connecticut StreamStats program, but do not account for potential special provisions. They do not reflect established minimum flow requirements, but were instead calculated in order to provide an estimate of future instream demands, and to support the future conditions assessment of the State Water Plan. There are also a number of exemptions that apply for safety, emergencies, limited/short term water use, instream uses, stormwater detention, small watersheds, certain man-made conveyances, and pollution abatement, which may alter these minimum flow requirements. Additional exceptions apply due to drought triggers or factor of safety triggers that can help avoid impacts to safe yield of a water supply during times of hydrologic stress.

Table 3-2. Preliminary Estimate of Minimum Required Releases (in cfs) for Multi-Level Release Rule Reservoirs*

		Bioperiod		Resident Spawning	Clepeid Spawning	Salmonid Spawning	Rearing and Growth - Wet	Rearing and Growth - Dry	Habitat Forming	Overwinter
		Effective Date		Jun 1 - Jun 30	May 1 - May 31	Nov 1 - Nov 30	July 1 - Oct 31	July 1 - Oct 31	Mar 1 - Apr 30	Dec 1 - Feb 28/29
Regional Basin ID	Reservior Name	Percentile		Q90	Q95	Q90	Q50	Q80	Q99	Q99
		System	Notes							
Multi-Level Release Rule (MLRR)										
71	Hemlocks Reservoir	Hemlocks	3	0.5	1.5	0.9	0.7	0.2	2.5	1.0
72	Saugatuck Reservoir	Hemlocks		9.8	21.9	10.2	10.7	4.7	25.6	8.6
71	Easton Lake Reservoir	Easton		3.7	8.4	3.7	3.8	1.6	9.8	3.0
71	West Pequonnock Div.	Easton		1.5	3.2	1.4	1.3	0.6	3.4	0.9
74	Bargh Reservoir	Mianus		5.8	12.7	5.2	5.9	2.6	14.4	3.9
45	Shenipsit Lake	Western		4.8	10.8	3.8	5.0	2.1	12.4	3.1
21	Ledyard Reservoir	Groton		1.7	3.8	1.7	1.6	0.7	4.2	1.6
40	Buckingham Reservoir	Manchester		1.1	2.7	1.1	1.2	0.4	3.3	1.0
43	Barkhamsted Reservoir	Barkhamsted		13.0	30.1	14.9	15.1	6.5	37.0	15.5
43	Nepaug Reservoir	Barkhamsted		11.6	24.1	10.4	11.6	5.6	26.0	8.8
52	Broad Brook Reservoir	Broad Brook		1.8	3.9	1.4	1.7	0.7	4.2	1.0
73	Grupes Reservoir	Grupes	2,4	2.2	5.6	2.6	2.5	0.9	7.0	2.4
39	Deep River Reservoir	Deep River		2.5	5.6	2.7	2.5	1.1	6.2	2.4
51	Lake Hammonasset	North Branford		5.8	12.9	6.2	6.1	2.6	14.9	5.8
51	Lake Menunkatuck	North Branford	3	0.4	1.2	0.7	0.5	0.1	1.9	0.9
51	Lake Gaillard	North Branford		0.6	2.0	1.1	0.9	0.2	3.5	1.7
53	Lake Dawson	West River	4	3.2	7.8	3.7	3.6	1.4	9.7	3.3
74	Mill River Reservoir	Stamford	3	0.2	0.7	0.5	0.3	0.1	1.5	0.9
74	Laurel Reservoir	Stamford		2.1	5.6	2.7	2.6	0.9	7.9	3.1
74	North Stamford Reservoir	Stamford		5.3	12.5	5.5	5.9	2.4	15.2	5.2
69	Reuben Hart Reservoir	Torrington s	3	0.2	0.9	0.6	0.4	0.1	1.8	1.2
69	Wigwam Reservoir	Wigwam		2.2	6.3	3.3	2.9	0.9	9.4	3.7
43	Rugg Brook Reservoir	Crystal Lake		2.2	5.7	2.9	2.6	0.9	7.6	3.1

Notes - Special provisions may exist for: *Sources: USGS StreamStats and CT DEEP*

1 - Drainage is less than 3 sq. miles

2 - Reservoir has 100 MG or less usable storage

3 - RGQ is between 0.1 and 0.2 cfs for public water supply

4 - Stream segments 1.5 miles or less between impoundments

**Some of these reservoirs and flows are exempted (e.g., Barkhamsted and Nepaug). The table is designed to show relative flows based on the methodology of the regulations. Data presented are only estimated releases based on limited information on reservoirs; actual release volumes will depend on additional reservoir-specific data.*

3.1.2 Future Water Supply and Demand Comparison

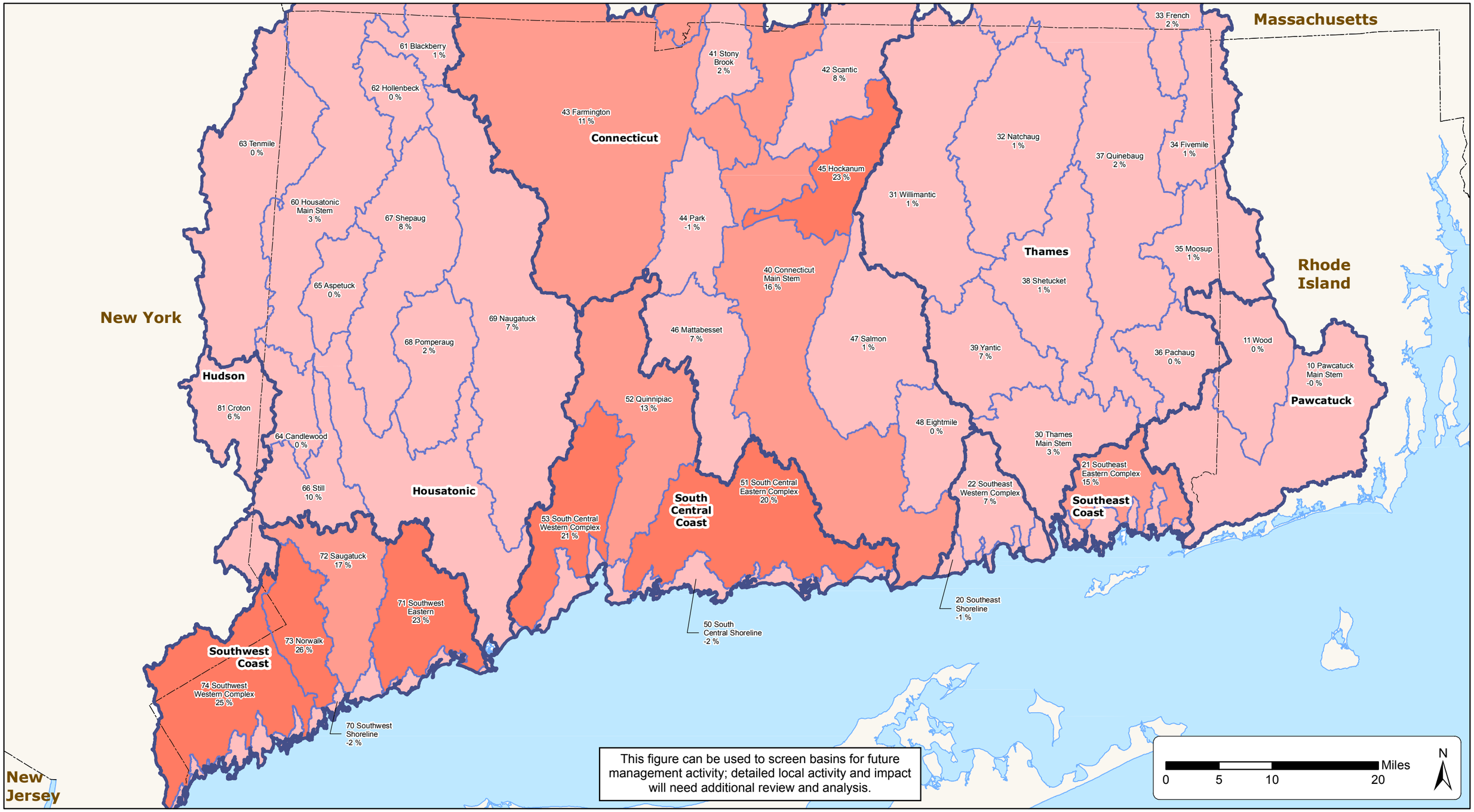
As with current water needs, future water needs can be compared to water availability as an indicator of future water stress (inability to satisfy all instream and out-of-stream needs) and to identify basins where gaps are most likely to occur. Future (year 2040) water needs for out-of-stream (consumptive) uses and reservoir release requirements as a percent of average annual streamflow for each regional basin are shown in **Figure 3-1**. In most of the regional basins, future out-of-stream water needs and reservoir release requirements are less than 10% of streamflow. In about one-third of the regional basins, future out-of-stream water needs and reservoir release requirements are less than 1% of streamflow. The highest percent of future out-of-stream water needs and reservoir release requirements compared to streamflow occurs in the Norwalk (26%), Southwest Western Complex (25%), and Hockanum (23%).

Total future out-of-stream and instream water needs as a percent of average annual streamflow for each regional basin are shown in **Figure 3-2**. Here, instream needs include those intended to support aquatic life, which are estimated as the Q50, or median flow. The highest percent of future need compared to streamflow occurs in the South Central Eastern (97%), Norwalk (93%) and Thames Main Stem (89%). Total water need is greater than 50% of average annual streamflow in all but one regional basin.

Future peak summer (July) out-of-stream water needs and reservoir release requirements as a percent of average July streamflow for each regional basin are shown in **Figure 3-3**. The highest percent of future July out-of-stream need compared to July streamflow occurs in the Southeast Eastern Complex (212%), Norwalk (208%) and South Central Eastern (156%). Total future peak summer water demand is greater than 100% of streamflow in 6 of the 44 regional basins and greater than 50% of streamflow in 10. Total future July out-of-stream and instream water needs as a percent of average annual streamflow for each regional basin are shown in **Figure 3-4.** The highest percent of future July out-of-stream and instream need compared to July streamflow occurs in the Norwalk (260%), Southeast Eastern Complex (256%), and South Central Eastern (243%).

Reclaimed water may be one opportunity to reduce or eliminate gaps in peak summer water needs. As shown in the water inventory (Table 2-1), the adjacent Southwest Shoreline and Norwalk regional basins have a combined 35 mgd of surface water discharge from centralized wastewater treatment facilities. Where feasible, making reclaimed water available presents a potential opportunity to reduce non-potable demand in the Norwalk regional basin, and alleviate future peak summer stress.

Maps of storage capacity within each basin under future water needs have also been prepared as a supplement to the supply/demand maps presented in this section, to help understand the potential value of storage as a buffer against high rates of seasonal water use. The months of usable storage at each regional basin's future average annual surface water demand, including demands associated with water supply (out-of-stream use) and ecological flow (instream use), is shown in **Figure 3-5**. This analysis assumes that storage is not replenished (no reservoir inflow) and also accounts for loss due to evaporation from the surface of the reservoir(s). **Figure 3-6** presents the months of usable storage at future summer (July) conditions, using the same assumptions regarding inflow and evaporation.



Legend

- Major Basin
- Regional Basin

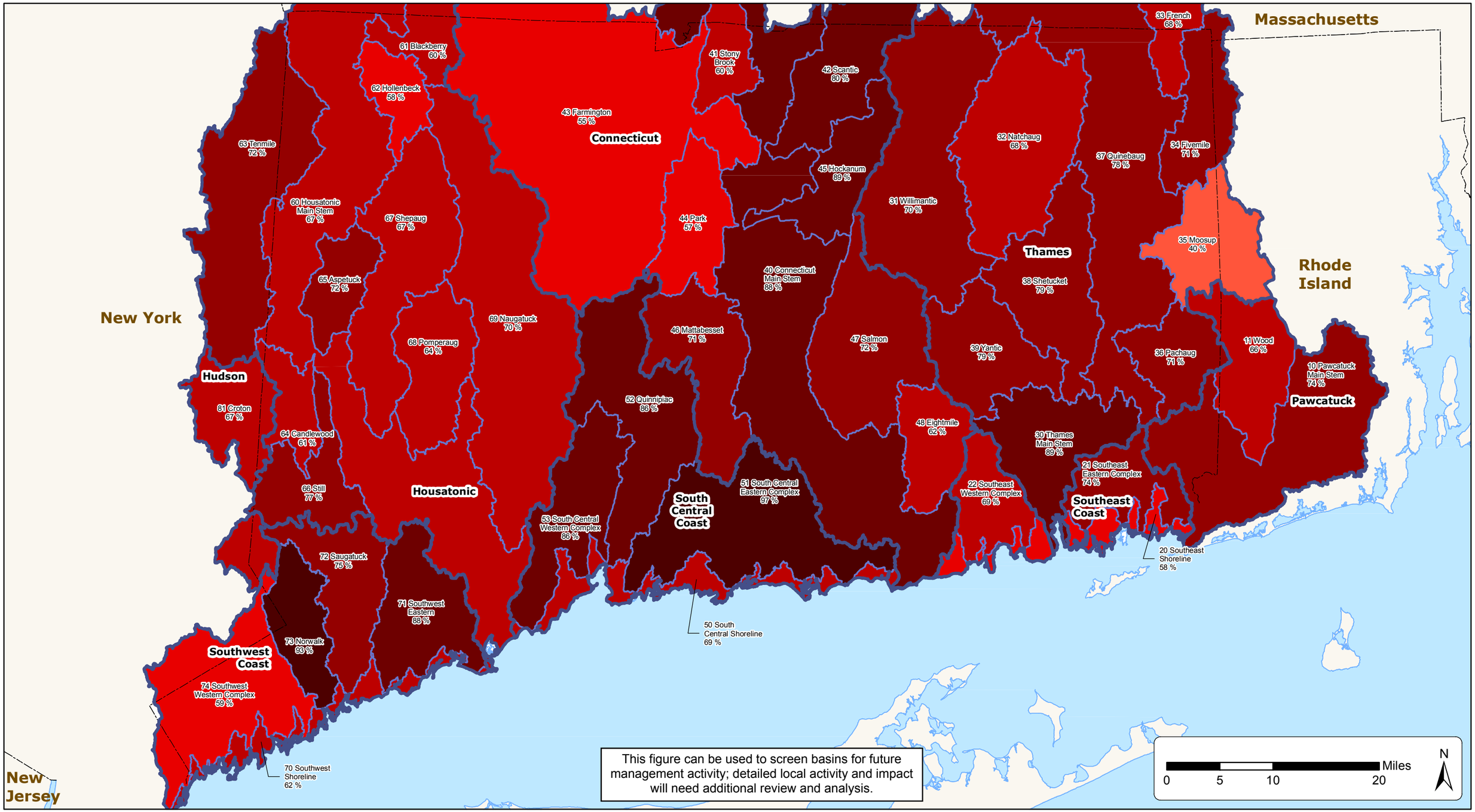
Future out-of-stream water needs and reservoir release requirements as a percent of average annual streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100

Figure 3-1
Future Out-of-stream Water Needs and Reservoir Release Requirements as a Percent of Average Annual Streamflow
Connecticut State Water Plan

CDM Smith | Milone & MacBroom®

May, 2017



Legend

- Major Basin
- Regional Basin

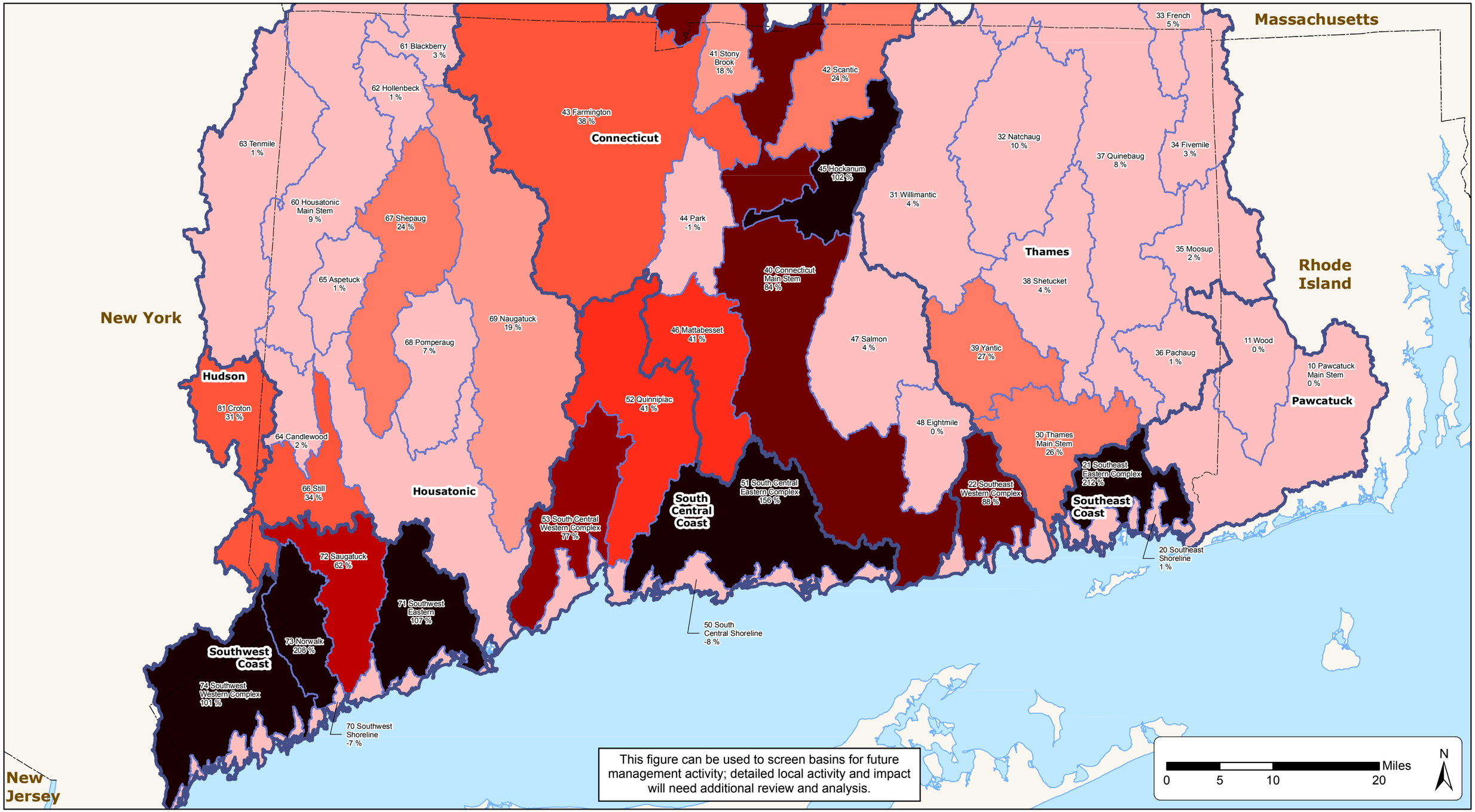
Future out-of-stream and instream water needs as a percent of average annual streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100

Figure 3-2
Future Out-of-stream and Instream Water Needs as a Percent of Average Annual Streamflow
Connecticut State Water Plan

CDM Smith | Milone & MacBroom®

May, 2017



Legend

- Major Basin
- Regional Basin

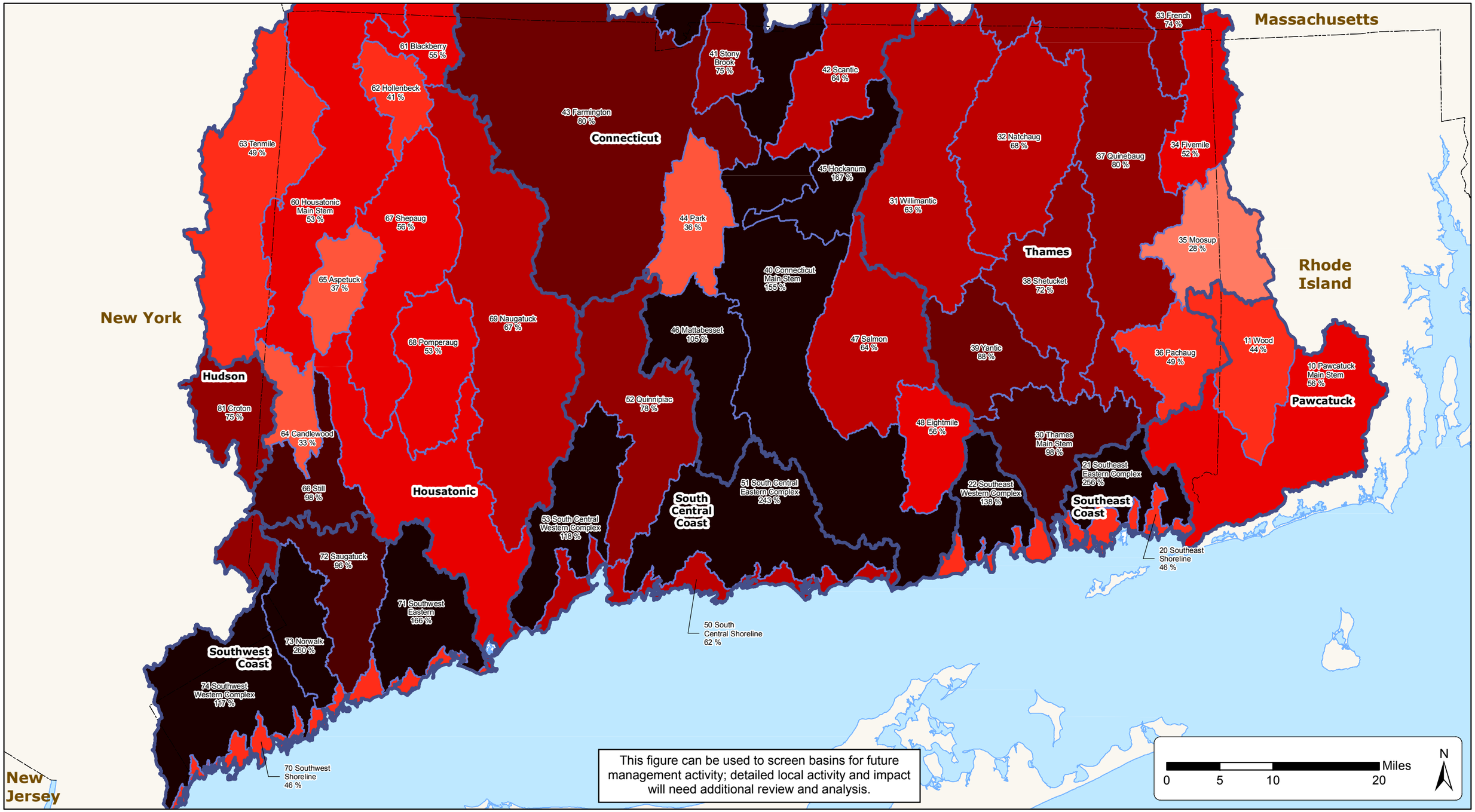
Future July out-of-stream water needs and reservoir release requirements as a percent of July streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90	> 100	
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100		

Figure 3-3
Future July Out-of-stream Water Needs and Reservoir Release Requirements as a Percent of July Streamflow
Connecticut State Water Plan

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May, 2017



Legend

- Major Basin
- Regional Basin

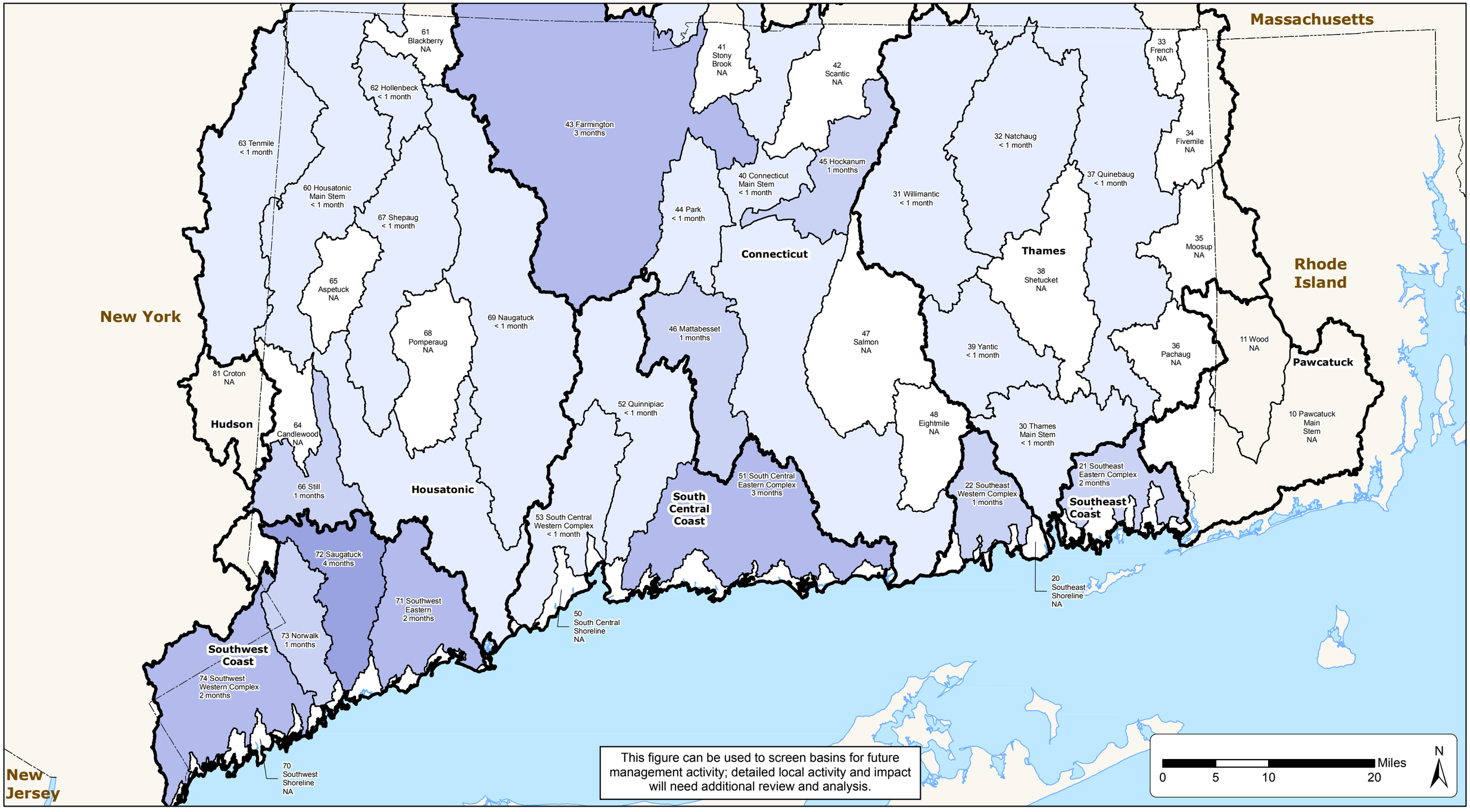
Future July out-of-stream and instream water needs as a percent of July streamflow (%)

< 10	20 - 30	40 - 50	60 - 70	80 - 90	> 100	
10 - 20	30 - 40	50 - 60	70 - 80	90 - 100		

Figure 3-4
Future July Out-of-stream and Instream Water Needs as a Percent of July Streamflow
Connecticut State Water Plan

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May, 2017



Legend

- Major Basin
- Regional Basin

Months of usable storage at future average annual out-of-stream and in-stream water demand

0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 6 | 6 - 9 | 9 - 12 | 12 - 18 | 18 - 24 | 24 - 36 | > 36

NA = Not Applicable (No Water Supply Reservoirs)

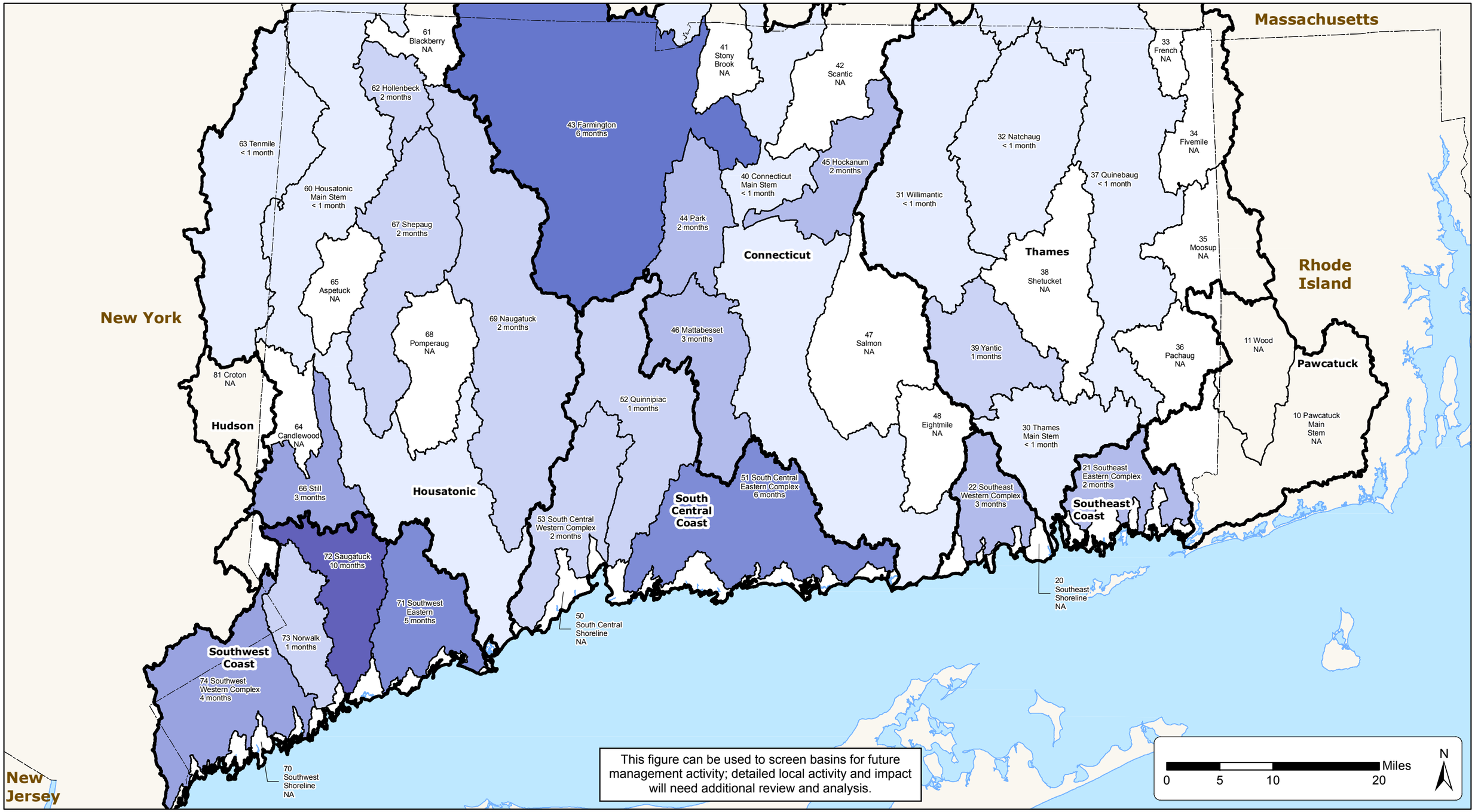
Figure 3-5

Months of Usable Storage at Future Average Annual Out-of-stream and In-stream Water Demand

Connecticut State Water Plan

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May, 2017



Legend

- Major Basin
- Regional Basin

Months of usable storage at future average July out-of-stream and in-stream water demand

0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 6 | 6 - 9 | 9 - 12 | 12 - 18 | 18 - 24 | 24 - 36 | > 36

NA = Not Applicable (No Water Supply Reservoirs)

Figure 3-6

Months of Usable Storage at Future Average July Out-of-stream and In-stream Water Demand

Connecticut State Water Plan

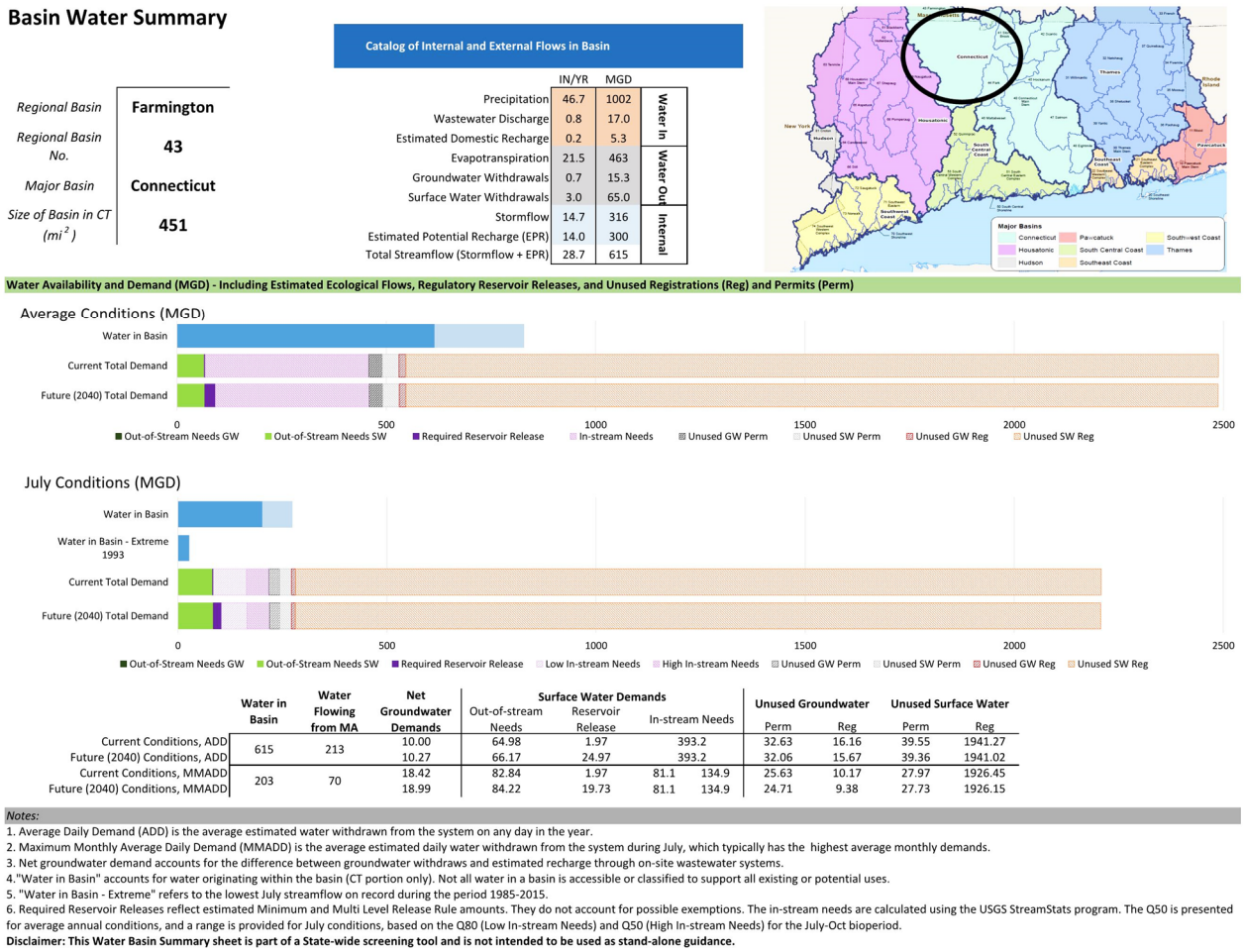
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The months of useable storage calculation accounts for both out-of-stream and instream demands. The in-stream demands are much less in July, compared to average annual. Depending on the basin, they are often greater than the out-of-stream demand (which is typically higher in July).

Regional basin water summary sheets were developed to provide present and future average day and peak month water needs, and to compare these needs to the amount of water in the basin (not including storage). Unused registration and permit limits were also included to provide an approximate indication of the amount of allocated water in each basin, for comparison to water in the basin. The regional basin summary sheets are included in Appendix E. It is important to note that unused registrations and permits were not included in the indicator maps of potential basin stress (inability to satisfy all instream and out-of-stream needs), since it is broadly agreed that not all of the registered volumes in every basin would be available (or needed) on a continuous basis.

An example summary sheet for the Farmington (No. 43) regional basin is provided in **Figure 3-7**. At the top of the sheet, the regional basins' water inventory is presented in both in/yr and mgd and a map is provided indicating the location of the regional basin. In the middle of the page, bar charts depict the water in the basin (streamflow) and a breakdown of demand types (or water needs) for both average day and maximum monthly (July) conditions. Near the bottom of the page is a table presenting current and future (year 2040) average day demands and maximum monthly (or peak summer) demands (in mgd). The dark blue bar represents water originating in the basin whereas the light blue bar represents water entering from out-of-state. Estimated instream and out-of-stream needs are shown separately. Like the out-of-stream needs, future instream needs are totaled for the entire basin. For July conditions, the July through October Q50 represents the "High Instream Need" and the July through October Q80 represents the "Low Instream Need" (see Section 2.1.4.3 for further explanation). Also shown are the total "unused" amount of groundwater and surface water, which is the difference between the sum of all permits and registrations in the regional basin and sum of demands. Similar summary sheets for all 44 regional basins are included as **Appendix E**. A "Users Guide" is included in Appendix E to aid in interpreting and understanding the data presented on the summary sheets.



Basin Water Summary

Regional Basin	**Farmington**
Regional Basin No.	**43**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**451**

Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.7	1002	Water In
Wastewater Discharge	0.8	17.0	
Estimated Domestic Recharge	0.2	5.3	
Evapotranspiration	21.5	463	Water Out
Groundwater Withdrawals	0.7	15.3	
Surface Water Withdrawals	3.0	65.0	
Stormflow	14.7	316	Internal
Estimated Potential Recharge (EPR)	14.0	300	
Total Streamflow (Stormflow + EPR)	28.7	615	

Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

	Water in Basin	Water Flowing from MA	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	615	213	10.00	64.98	1.97	393.2		32.63	16.16	39.55	1941.27
Future (2040) Conditions, ADD			10.27	66.17	24.97	393.2		32.06	15.67	39.36	1941.02
Current Conditions, MMADD	203	70	18.42	82.84	1.97	81.1	134.9	25.63	10.17	27.97	1926.45
Future (2040) Conditions, MMADD			18.99	84.22	19.73	81.1	134.9	24.71	9.38	27.73	1926.15

Notes:
1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4."Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Figure 3-7. Basin Water Summary Sheet of the Farmington Regional Basin
(Shown as an example – the full set of Summary Sheets for all 44 basins is included as Appendix E)

The summary sheets indicate that on an average daily basis, the basins in Connecticut appear to be well supplied with water to meet the needs of current and projected future out-of-stream uses. When instream uses, including those necessary to support aquatic life are considered, gaps become apparent especially in the summer months, although storage and flow management plans may alleviate this to varying degrees. Again, the maps and fact sheets offer indications of potential stress within basins (inability to satisfy all instream and out-of-stream needs), but do not necessarily forecast overuse or underuse. It is also important to remember that because these data are regionalized by basin, they are *indicators* of potential future stress, and not actual predictions of future stress. Water may be plentiful basin-wide, but it is possible that specific segments of the stream may be stressed. Detailed evaluations of specific utilities or water systems at a more local scale would be required.

Lastly, the summary sheets clearly illustrate that on paper, many of the state's basins are over allocated because of unused water registrations and permits. Registrations were authorized without environmental reviews or consideration of the full range of hydrologic conditions. Many of these unused registrations are not expected to ever be needed or applied on a continuous basis, and therefore the Plan attempts to identify a reasonable upper limit on expected future

water use in basins where unused registrations clearly exceed the available water and the projected demand.

The basin water summary sheets were vetted as screening tools using some of the recent knowledge about impacts to three regional basins during the 2016 drought. These examples are presented below:

- Quinnipiac River Basin: The maps and basin summary sheet suggest a moderate-to-high risk that the Quinnipiac Basin may not be able to support all of its needs during average annual conditions or typical summer conditions. There are 1-2 months of storage in the basin that can partially offset concerns about short-term seasonal droughts. The basin summary sheet, however, suggests that during severe drought conditions, there will not likely be sufficient water in the basin even to satisfy all out-of-stream needs (though the tools do not indicate specifically where such problems might occur). Indeed, during 2016, flow in the mainstem Quinnipiac dropped to approximately 1 cfs near the town of Southington.
- Pomperaug River Basin: The maps above show that under average conditions and typical summer conditions, the Pomperaug River Basin can likely satisfy its instream and out-of-stream needs (requiring about 55% to 65% of naturally occurring water). However, the basin summary sheet for the Pomperaug Basin suggests that during significant drought conditions (similar to 2016), the out-of-stream needs amount to about 80% of available water, and there would not be enough remaining water expected to satisfy instream needs. Indeed, during 2016, anecdotal evidence suggests that certain reaches in the basin were nearly dry. Again, the screening methodology does not pinpoint the location or severity of stream or aquifer depletion, but the tools can be used to identify the relative level of risk under various conditions.
- Farmington River Basin: Similar to the Pomeraug, the Farmington Basin shows only moderate risk during average conditions, but the risk rises sharply during typical summer conditions. During severe drought conditions, it is not expected that there will be enough water flowing naturally in the basin to satisfy all needs, or even the out-of-stream needs on their own. However, much of the storage in the state is located in the Farmington basin, and the storage map indicates that the basin can store between 6 and 9 months of supply at expected July demand levels. This would be an effective offset to concern about seasonal drought, though the findings suggest that even this basin could be susceptible to multi-year droughts. And to vet the screening process, most of the basin was sufficiently supplied during the 2016 drought, but (as suggested by the comparison of available water to out-of-stream needs), the Coppermine Brook (a tributary) did run dry in 2016. This is a good example of how the screening tools can be used to indicate the presence of risk, but not pinpoint the specific location, and also to illustrate potential offsets on a spatially-averaged basis.

3.1.3 Potential Impacts of Water Conservation on Supply and Demand Balance

Water conservation occurs in the form of both active conservation efforts (such as educational programs, customer incentives or conservation ordinances) and passive conservation which results from improvements in the efficiency of water fixtures such as toilets, showerheads and

clothes washers due to manufacturing standards and plumbing codes. Potential, theoretical year 2040 reductions in public supply water demand from conservation have been estimated for each of the 44 regional basins. Three future scenarios of conservation were applied to determine the extent that possible water conservation may help improve the ability of each basin to satisfy both instream and out-of-stream needs in 2040. The scenarios developed include:

- Scenario I – Current federal code effects on indoor use;
- Scenario II – Ultra-efficient indoor use; and
- Scenario III – Ultra-efficient indoor use with a 20 percent reduction in outdoor use

The percent reduction in public-supplied residential water demand is estimated by reducing the gallons per capita per day (gpcd) of water systems within each basin by the gpcd reduction imposed by each of the three scenarios.

Research shows that residential indoor water use nationwide has decreased 15.4% since 1999 from 69.3 gpcd to 58.6 gpcd, and homes built according to the EPA's WaterSense New Home Specification use 37% less water than the average home now and 47% less than the average home in 1991. This reduction in indoor water use is largely due to the water efficiency standards for fixtures from the EPA's Energy Policy Act of 1992 and newer WaterSense standards introduced in 2007. WaterSense fixtures will become more prevalent in future years – the Department of Energy's Zero Energy Home Requirements and LEED building standards both recommend the use of WaterSense fixtures2.

For this analysis, an average indoor water use of 60 gpcd is assumed for all homes in Connecticut for the baseline scenario (existing forecast without conservation reductions). An additional 10 gpcd savings will likely be achieved naturally given the current minimum federal requirements for domestic water fixtures, which is represented in Scenario I. These savings are truly "passive" and will occur naturally as fixtures are replaced in older homes and newer homes are built per current code.

An EPA post-retrofit study indicates that indoor water use can be reduced to 37 gpcd by using all EPA WaterSense fixtures and eliminating all leaks[3]. These savings go beyond the "passive" forecast to assume that state codes (or by some other measure) exceeds the federal requirements and all existing homes are eventually retrofitted and all new homes are built assuming WaterSense ultra-efficient water savings fixtures. Based on these assumptions, Scenario II assumes that indoor water use can be reduced from 60 to 40 gpcd, or a savings of 20 gpcd.

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[1] DeOreo, William B., Peter Mayer, Benedykt Dziegielewski, and Jack Kiefer. 2016. *Residential End Uses of Water, Version 2.* Denver, CO: Water Research Foundation.

[2] The LEED standards state, "as applicable to the project scope, reduce aggregate water consumption by 20 percent from the baseline." The baseline is the fixture standards from the Energy Policy Act and they recommend achieving this reduction through the use of WaterSense certified fixtures.

[3] Aquacraft: Water Engineering & Management. 2011. Albuquerque Single-Family Water Use Efficiency and Retrofit Study. Prepared for: Albuquerque Bernalillo County Water Utility Authority.

Scenario III assumes the 20 gpcd reduction from WaterSense ultra-efficient water savings fixtures as well as reduction in seasonal, outdoor water use. As the potential savings for outdoor use is less certain, a conservation 20 percent reduction was assumed.

3.1.3.1 Data Sources and Assumptions

Data for this analysis were obtained from the 44 regional basin water summary sheets. Within these files the water demand for residents using private wells is defined as Estimated Domestic Withdrawals (EDW). This volume of demand within each basin is determined as the basin population not served by a public water supply times the rate of 61.2 gpcd. The EDW rate of 61.2 gpcd is used consistently in all basins.

The data for each basin identify Surface Water Withdrawals (SWW) and Groundwater Withdrawals (GWW). The SWW demand is separated between specific water providers and "Other". The GWW demand is separated between specific water providers, "Mid-size Systems" and "Small Systems". The 2010 population is provided for each specific water provider. The gpcd was calculated for each specific system given the 2010 population and the 2010 MGD.

Some systems have both surface water and groundwater sources, with the same population associated with each withdrawal amount. Therefore, the SWW and GWW were added together and divided by the population, and the resulting rate was assigned to the respective system. Some systems are cross listed in multiple basins, but the same population is associated with each withdrawal amount. Therefore, the withdrawals in each basin were added together and divided by the population, and the resulting rate was assigned to the respective withdrawals in each basin. The estimated rates averaged 137.4 gpcd.

An indoor water use of 60 gpcd was assumed for all systems. Those systems with a gpcd volume of 60 or less are assumed to not be affected by future water conservation efforts. Thus, there is not estimated impact of conservation for some systems.

An estimated 2040 gpcd was estimated for each system for each scenario. The year 2040 rate was multiplied by the 2040 population of each system to derive a 2040 rate for each system for each scenario. The 2010 rate and the 2040 rate for each scenario was aggregated by basin for all systems within each basin. A percent reduction in rate from 2010 to 2040 was calculated by basin for each scenario.

It can be assumed that this percent reduction by basin and scenario is applicable to all surface water and groundwater demands. That is, while the percent reduction is derived from specific system data, it can be assumed that different size systems will experience the same percent reduction as the specific systems within a given basin. A separate percent reduction was calculated for the EDW demand that is applicable for all basins.

3.1.3.2 Scenario I

For Scenario I, a decrease of indoor use from 60 gpcd to 50 gpcd is assumed given saturation over time for the current federal codes that affect toilets, faucets, showerheads, clothes washers and dishwashers. This amounts to a reduction of 10 gpcd for each system.

Toilets, faucets, showers, and clothes washers make up the bulk of indoor usage in the United States (see **Table 3-3**).[4] A steady reduction in water usage over time can be expected simply from new and remodeled building compliance with federal fixture standards set out by the EPA's Energy Policy Act of 1992 and the newer WaterSense standards introduced in 2007 (see **Table 3-4**). Rather conservatively, it is expected that if Connecticut makes no extra efforts to conserve water a reduction of 10 gpcd can still be expected. This expected reduction assumes that the saving are passive, meaning there are no educational campaigns nor incentives to retrofit older buildings.

Table 3-3. Indoor Household Use by Fixture

							
Toilet	Faucet	Shower	Clothes Washer	Leak	Bath	Other*	Dishwasher
24%	**20%**	**20%**	**16%**	**13%**	**3%**	**3%**	**2%**
32.6 gphd	27.0 gphd	26.9 gphd	22.0 gphd	17.8 gphd	4.4 gphd	4.0 gphd	2.2gphd

*Other includes evaporation cooling, humidification, water softening, and other uncategorized indoor uses.

Table 3-4. Water Sense Fixture Standards[5]

Fixture	WaterSense Standard
Toilet	<=1.28 gpf
Flushing Urinals	0.5 gpf
Showerhead	<=2.0 gpm
Faucet, bathroom	<=1.5 gpm
Faucet, kitchen	<=2.2 gpm
Clothes washer	<=6.0 per cycle per cubic foot
Leaks	No detected leaks

3.1.3.3 Scenario II

For Scenario II, a decrease of indoor use from 60 gpcd to 40 gpcd is assumed given compliance over time with the current federal codes, elimination of leaks and installation of EPA WaterSense ultra-efficient water saving appliances and fixtures. This amounts to a reduction of approximately 20 gpcd for each system in Connecticut alongside a more aggressive campaign to retrofit all businesses with the most efficient fixtures available or a statewide code that requires WaterSense fixtures in plumbing codes (see **Table 3-5**).

[4] DeOreo, William B., Peter Mayer, Benedykt Dziegielewski, and Jack Kiefer. 2016. Residential End Uses of Water, Version 2. Denver, CO: Water Research Foundation.

[5] EPA. *WaterSense New Home Specification.* Effective July 24, 2014. https://www3.epa.gov/watersense/docs/home_finalspec508.pdf

Table 3-5. Standard and Ultra-Efficient Fixture Comparison

Fixture	Standard	Ultra-efficient*
Bathroom Sink Faucet and Accessories	2.2gpm	<=1.5gpm
Clothes Washer	<30gpl	<15 gpl
Faucet, kitchen	>2.5gpm	<1.6gpm
Faucet, bathroom	>1.5gpm	<1.0 gpm
Flushometer Valve Toilets	1.6gpm	>=1.28gpf
Landscape Irrigation Controllers	Save an average home 8800gpy(year)	
Pre-Rinse Spray Valve (Industrial Kitchen)	1.6gpm	1.28gpm
Showerhead	>2.5gpm	<1.6gpm
Toilet	3.5+gpf	<=1.28gpf

*In some cases this is the WaterSense standard, in others it is the most efficient available.

Per a study conducted in Albuquerque[6] this level of retrofitting campaign is effective and proven to reduce indoor gpcd. In 2009, the study found that nearly 50 percent of toilet uses, 37 percent of clothes washes, 47 percent of showers, 75 percent of faucet uses, and 9 percent of leakages were at or below a high efficiency benchmark. The uses above the high efficiency benchmark accounted for most of the reduction in water usage post retrofit. The study documented current water usage of 138 gallons per household per day (gphd) and projected a reduction to 101 gphd if all homes were retrofitted with high efficiency fixtures. This is a projected reduction of 27 percent; however, it should be noted that they believed the control group had higher than average water usage compared to all households in Albuquerque.

3.1.3.4 Scenario III

For Scenario III, a decrease of indoor use from 60 gpcd to 40 gpcd is assumed according to the assumptions outlined in Scenario II. The ultra-efficient indoor measures are paired with a reduction in 20 percent of the outdoor usage for each system. This results in a reduction of 20 gpcd indoor usage for each system plus an assumed 20 percent reduction in the remainder of the gpcd, which represent outdoor water use.

There are many measures that can be taken to reduce outdoor usage including educational campaigns on landscaping and other outdoor uses, the installation of "smart controllers", soil moisture sensors or drip irrigation, rain barrels, graywater recycling, and irrigation restrictions. According to DeOreo et al. (2016), efforts to reduce outdoor water usage should target the customers who are over irrigating, prevent low irrigators from increasing irrigation practices, and reduce planting areas if possible.

Behavioral changes - which can be disseminated through educational campaigns – can lead to significant reductions in outdoor usage (see **Table 3-6**). Installing new technology to regulate water flow can also significantly reduce outdoor usage (see **Table 3-7**). Graywater recycling is another way to reduce water usage – per the EPA a good greywater system can reuse up to 60

[6] Aquacraft: Water Engineering & Management. 2011. Albuquerque Single-Family Water Use Efficiency and Retrofit Study. Prepared for: Albuquerque Bernalillo County Water Utility Authority.

percent of household water for irrigation, although these systems can be strenuous and expensive to maintain.[7]

Table 3-6. Outdoor Water Savings from Behavioral Changes

Measure	Reduction
Use a broom to clean outdoor areas	8-19 gallons per minute
Use mulch on soil	20-30 gallons per sq ft per watering
Adjust sprinklers so they are not watering non-plant surfaces	12-15 gallons per watering
Water plants in the early morning	25 gallons per watering
Install rain barrels	Capacity 55 gallons (depends on precipitation/number of barrels)

Table 3-7. Outdoor Installations to Reduce Usage

Measure	Reduction
Install a "smart controller"	24+ gpd or -15%
Install drip irrigation	15 gallons per watering
Install a soil moisture sensor	-35 to 45%

Significant reductions in outdoor usage can also be attained through restrictions on sprinkling during summer months. For example, restricting water usage to 3 mornings per week during the summer has the potential to reduce total seasonal usage by 4.2 to 7.2 percent[8]. Finally, installing meters and billing according to usage can reduce water consumption by 15 to 30 percent.

Currently in Connecticut, water utilities serving more than 1,000 people are required to maintain a Water Conservation Plan per the Individual Water Supply Plan regulations. These local plans are varied and focus on both supply and demand management. Supply management is focused on reducing the loss of water through metering, water accounting, leak detection/repair, etc. Demand management focuses on the reduction of the peak and average daily demands of customer usage through residential retrofits, public awareness campaigns, and strategic rate-setting among other things.

3.1.3.5 Results

The estimated percent reduction by regional basin and scenario is shown in **Table 3-8**. A weighted average percent reduction is calculated based on relative water use by regional basin, as shown at the bottom of the table. The EDW percent reduction is also shown at the bottom of the table. Note that there are eight regional basins that do not have specific system SWW or GWW. Thus, there is no percent reduction calculated for these, and the weighted average percent reduction was used.

[7] EPA - https://energy.gov/sites/prod/files/guide_to_home_water_efficiency.pdf

[8] Kerr Wood Leidal: Consulting Engineers. 2016. *Technical Review of the Water Shortage Response Plan.* Prepared for Metro Vancouver: Services and Solutions for a Livable Region.

Table 3-8. Estimated Potential Percent Reduction by Basin for Scenarios I, II and III

Basin		% Reduction for 2040		
		Scenario I	Scenario II	Scenario III
10	Pawcatuck	12.8	25.6	30.2
20	Southeast Shoreline	0.0	0.0	0.0
21	Southeast Eastern Complex	3.6	7.2	22.9
22	Southeast Western Complex	4.4	8.8	23.5
30	Thames Main Stem	0.0	0.0	0.0
31	Willimantic	5.0	9.9	24.0
32	Natchaug	10.1	20.2	28.1
33	French	8.4	16.7	26.7
34	Fivemile	4.3	8.6	23.4
37	Quinebaug	8.8	17.6	27.0
38	Shetucket	0.0	0.0	0.0
39	Yantic	9.6	19.2	27.7
40	Connecticut Main Stem	8.2	16.4	26.6
41	Stony Brook	3.9	7.7	23.1
42	Scantic	4.1	8.1	23.2
43	Farmington	8.4	16.8	26.7
44	Park	7.8	15.6	26.2
45	Hockanum	5.2	10.4	24.1
46	Mattabesset	7.0	14.0	25.6
47	Salmon	11.4	22.9	27.7
51	South Central Eastern	10.4	20.8	28.3
52	Quinnipiac	5.4	10.8	24.3
53	South Central Western Complex	0.0	0.0	0.0
60	Housatonic Main Stem	0.0	0.0	0.0
61	Blackberry	4.7	9.5	23.8
62	Hollenbeck	7.0	14.0	25.6
64	Candlewood	3.8	7.6	16.4
66	Still	8.2	16.4	26.6
67	Shepaug	4.5	9.0	23.6
68	Pomperaug	1.4	2.8	4.0
69	Naugatuck	4.1	8.3	21.3
71	Southwest Eastern	11.6	23.2	29.3
72	Saugatuck	11.6	23.2	29.3
73	Norwalk	8.0	16.0	26.4
74	Southwest Western Complex	4.7	9.4	23.8
81	Croton	5.8	11.6	24.6
	Weighted Average % Reduction	**6.7**	**13.3**	**23.1**
	Estimated Domestic Withdrawal (EDW) % Reduction*	**16.3**	**32.7**	**32.7**

The Southwest Shoreline, Aspetuck, Tenmile, South Central Shoreline, Eightmile, Pachaug, Moosup, and Wood regional basins did not have specific system SWW or GWW, therefore the weighted average was used.
**Outdoor gains in efficiencies are not assumed for the self-supplied domestic population*

The percent reductions for SWW/GWW and EDW were applied to the water demand estimates for these categories estimated for each basin, and the total reduction in water demand was calculated for each of the three scenarios. Note that the percent reductions do not apply to agricultural or industrial water use. The 2040 estimated water demands (in MGD) with no conservation, and under conservation Scenarios I, II and III are shown graphically in **Figure 3-8** for each regional basin. As might be expected, the largest potential reductions are in the regional basins with the highest withdrawals. The Farmington Basin, for example, might expect reductions of over 7.0, 15.5, and 18.6 MGD under Scenarios I, II and III respectively. In the Norwalk regional basin, smaller but still meaningful reductions of 1.5, 3.1 and 3.8 MGD might be expected under the three scenarios. There, the estimated future average annual needs for both instream and out-of-stream uses are 93% of streamflow. With the Scenario 3 reductions, this lowers the in- and out-of-stream water needs to 88% of streamflow – providing a bit more of an already small buffer to help meet water needs. In a drought situation, when the needs would exceed streamflow, these savings are much more important.

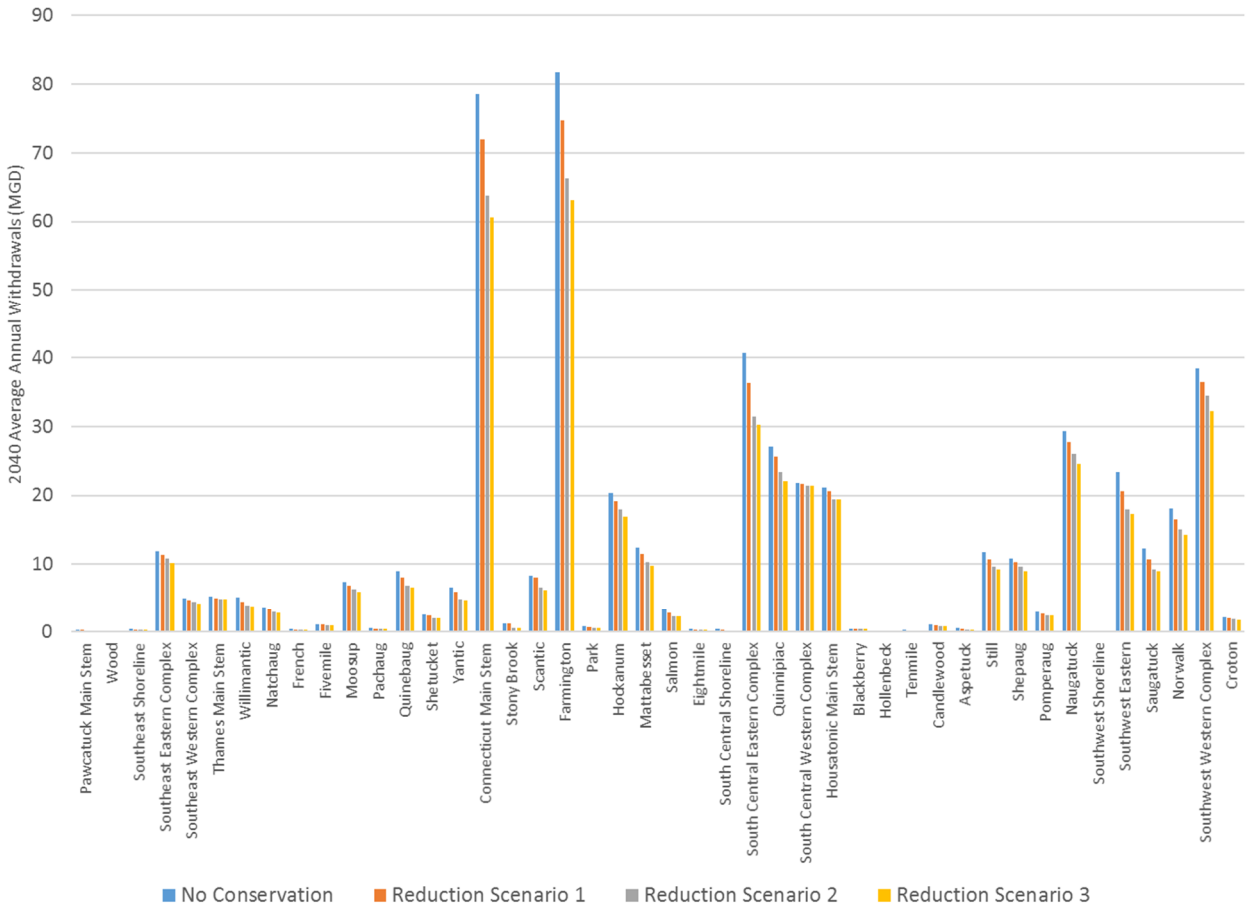


Figure 3-8. 2040 Average Annual Withdrawals Under No Conservation and Scenarios I, II and II

3.1.4 Potential Impacts of Climate Change

3.1.4.1 Objectives

The objective of this task was to synthesize and summarize the suite of available climate change projections for the State of Connecticut into a practical, useful, and comprehensive data set for

use in subsequent water resources analyses. It is hoped that the summary data set will have utility on its own for providing insight into the range of possible climate outcomes for the state, and also serve as an experimental data set to test future conditions in specific basins as necessary. Note that the goal of this analysis is not to predict the future climate for the state, but to define a range of conditions that are deemed scientifically possible based on state-of-the-art climate modeling.

Climate forecasts typically extend for 50 – 100 years, which exceeds the 25-year planning horizon for the Plan. However, the data set can be easily scaled or adjusted to provide bounded possible climate scenarios for any future decade within the 100-year horizon. Results in this section correspond to year 2080, a horizon of approximately 60 years, in order to show significant possible trends. Following the presentation of the analysis, a summary of other literature on Connecticut climate trends is presented for comparison (see end of **Section 3.1.4.3**).

3.1.4.2 Methods

Future climate scenarios for the state were developed utilizing a combination of state-of-the-art climate models and historically available climate observations. All scenarios are intended to represent discrete plausible climate futures centered on a 2080 planning horizon. No attempt is made to assess the likelihood that these potential climate futures will occur, but rather they are presented as a range of projected conditions based on the best available science and engineering.

Future climate projections for the state have been summarized under this task using the full suite of available global climate model (GCM) projection data sets. These projections include monthly mean air temperature and monthly total precipitation, downscaled to a 1/8th-degree latitude/longitude grid. These published data were obtained from public data portal maintained by the U.S. Bureau of Reclamation (http://gdodcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html).

A total of 110 different climate model projections were downloaded for the period 2000 to 2100. A modeling overlap period of projections and a historical observed dataset (gridded to same 1/8th-degree grid) were also obtained for the years 1950 to 1999. All projections represent the latest in scientific research and were developed under the World Climate Research Programme Coupled Model Intercomparison Project, Phase 5 (CMIP5). The CMIP5 data set includes 35 different climate models developed at top research institutions around the world and applied across a range of model input assumptions. No attempt was made to assess the likelihood of these models being correct or not. Rather, they were used to test plausible future climate scenarios for this study.

Climate model projections were obtained for a single, centrally located 1/8th-degree grid cell for this analysis (**Figure 3-9**). The selected cell is considered representative of the central region of the state, with respect to climate variability, and at a suitable distance from urban centers to avoid any potential urban heating influences.

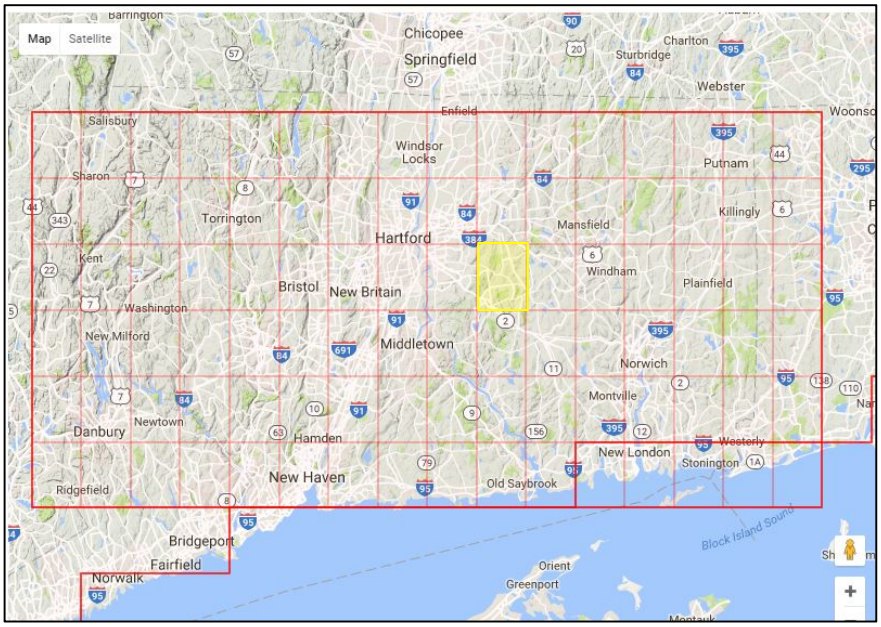


Figure 3-9. Representative Climate Model Projection Grid Cell (yellow highlight)

A sampling band of ± 10 years, centered on 2080, was used to capture natural year to year variability in the climate data, while still being representative of late 21st century climate trend projections

Climate model data were pooled into four different ensembles (groups), each of which is used to develop different future climate scenarios which a.) illuminate the range of projected variability and uncertainty b.) provide insight into the ramifications of different greenhouse gas emissions pathways, and c.) can each be easily used in subsequent water resources analyses and modeling. The scenarios are intended to be viewed as equally plausible – that is, no predicted outcome is assumed to have any higher or lower probability of occurring than any other (**Figure 3-10**). All 110 GCM projections, downscaled to the selected grid cell noted above, are represented on this plot as discrete points. Four different climate data ensembles were constructed using this plot representing the four boxed quantile ranges shown in the figure.

1. Hot/Dry: 50th to 100th percentile Temp, 0 to 50th percentile Precip
2. Hot/Wet: 50th to 100th percentiles Temp and Precip
3. Warm/Wet: 0 to 50th percentile Temp, 50th to 100th percentile Precip
4. Warm/Dry: 0 to 50th percentile Temp and Precip.

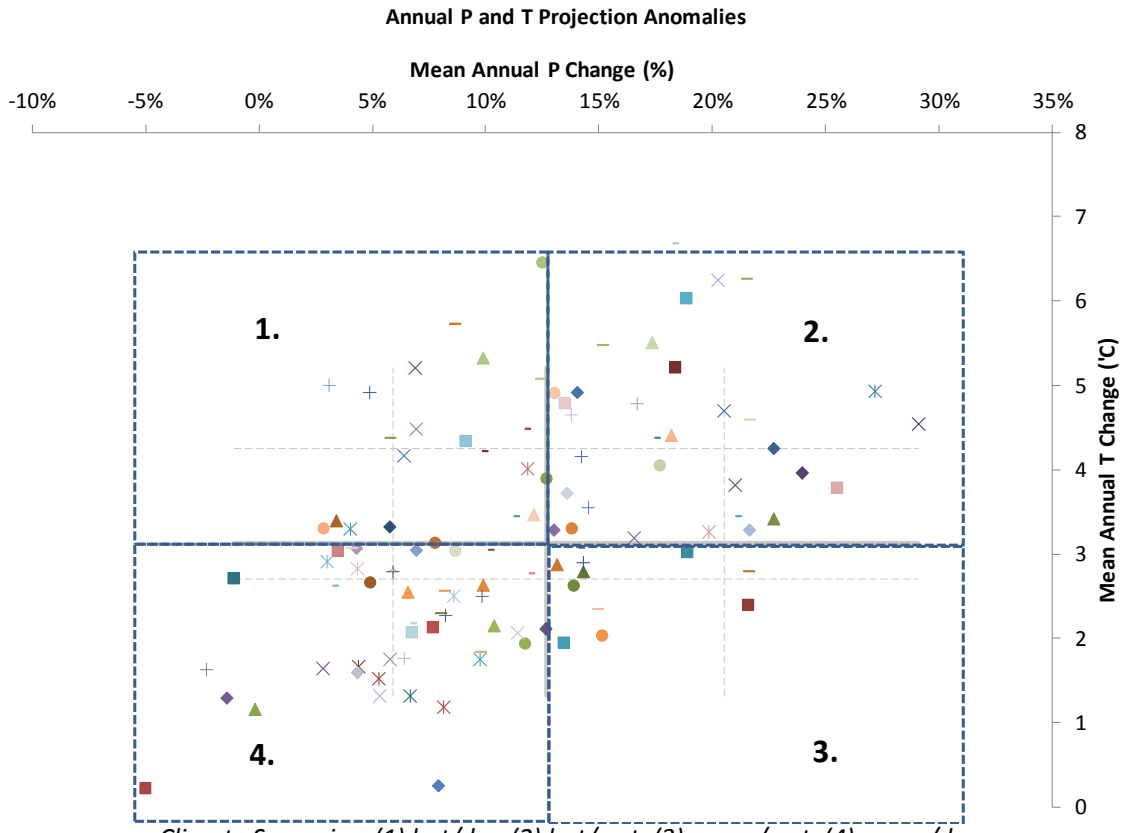


Figure 3-10. Annual Anomalies (2080 vs. historical) of GCM Temperature and Precipitation Projections, with Designated Scenario Ensembles (each symbol represents a different climate model projection set)

Data from all model projections residing within a given quantile box were pooled to create the four ensembles. In this way, all available climate projections were used and no projection was used in more than one ensemble. Advantages of this approach, as advocated by Reclamation (Reclamation 2010) are that it allows for easy visualization of the range and uncertainty in climate projections and does not require subjective selection of model projections, while at the same time still providing a practical number of pooled scenarios for use in subsequent analyses.

For each climate model ensemble, a method referred to as the "hybrid delta ensemble" (HDe) method (Reclamation, 2010) was applied to adjust historical climate records to reflect the four future climate projection data sets (See Appendix F for details on this approach). In this method, statistical adjustments are made to the historical observed data set (1950 – 1999) based on relative changes predicted by the pooled GCM projections. In this way, this method preserves the month-to-month pattern of variability and many of the core statistics of the observed historical record in its forecast of future conditions. The method has been used extensively by the U.S. Bureau of Reclamation and others as a means of incorporating climate model projections into water resources planning studies.

The "delta" in the HDe name refers to the difference between GCM forecasts of the future vs. GCM hindcasts of the past. The "hybrid" term refers to the fact that the method uses a range of delta values to adjust the historical record based on relative climate conditions. For example, during wet observed periods calculated deltas associated with wet modeled periods are used. Similarly,

during observed dry periods, dry modeled period deltas are used to adjust the record. The same principle is applied in adjusting the temperature record. The advantages of this approach are that it is often more palatable to stakeholders because it is so strongly tied to actual observed climate data (rather than using model projections by themselves) and it eliminates any overriding bias in the GCMs by using delta values (modeled vs. modeled) rather than the projection data themselves. See Appendix F for further details on the HDe methodology.

Note that the 1950 to 1999 period was selected as the historical climate baseline period for this study for a number of reasons. First, we desired to follow, as closely as possible, well established and published methods for developing climate scenarios for water resources planning. The 1950 to 1999 period is standard in Reclamation's HDe approach. There are seemingly multiple reasons for this. Firstly, historical climate observations projected onto the same 1/8th-degree spatial grid as the climate model projections, and critical to the approach, are only available for this limited historical period (Maurer et al. 2002). Secondly, all of the climate models used in this study have been trained (calibrated) to the 1950 to 1999 period as part of the model downscaling task. Model output beyond 1999 are pure projection and are not directly linked to observed data. There are therefore numerical advantages and increased defensibility in using this period as a baseline for calculating climate delta values (modeled future minus modeled baseline). Lastly, the past ten years globally have been among the hottest on record. Including this decade in the historical baseline, intended to represent a stationary past, would therefore be somewhat inappropriate and potentially make the approach less defensible. This was undoubtedly a consideration in Reclamation's original methodology development.

The result of the HDe method is a set of four different 50-year climate data sets that are reflective of 2080 conditions, as projected by climate model, but maintain the same pattern of variability observed in the recent historical record (1950 – 1999). Results are presented below.

3.1.4.3 Results and Discussion

As evidenced by the annual anomaly plot presented above (Figure 3-10), there is general consensus in the climate models for a hotter and wetter future. Mean annual temperature changes for the 2080 planning horizon, compared to historical baseline, range from approximately +0.5 ˚C to + 6.5 ˚C. Mean annual precipitation changes range from approximately -5% to +30%, with the vast majority of the projections predicting an increase in mean annual precipitation.

Results of the hybrid delta ensemble (HDe) analysis are presented in **Figures 3-11** through **3-18**. Each figure shows a comparison of historical observed data to the same data set adjusted to reflect 2080 climate model projections. Summary output includes a.) monthly time series plots of average temperature and total precipitation, b.) mean monthly temperature and precipitation bar charts, and c.) monthly temperature and precipitation percentile plots. The first summarizes the raw output and illustrates month to month variability, the second provides insight into the seasonality of the projected changes, and the third shows the full range of projected changes, including extreme months. Differences across sets of ensemble plots highlight the variability and uncertainty associated with the climate model projections and potential differences associated with greenhouse gas emissions pathways. For example, the "hot/dry" ensemble projects a mean monthly temperature change of 4.5 ˚C and a mean monthly precipitation change of 10

mm/month, while the "warm/wet" ensemble projects a temperature change of 2.6 ˚C and a precipitation change of 17 mm/month.

As noted above, all GCM ensembles project an increase in temperature for all calendar months. Projected temperature changes appear relatively consistent across calendar months and percentile levels, for each of the ensemble scenarios. In other words, both summer and winter temperatures are projected to increase by similar amounts; and a similar shift is observed for both extreme cold and extreme hot months. Precipitation projections are more variable, although consistently projecting a generally wetter future for all four scenarios. The largest precipitation increases are projected for the wetter months (higher percentiles), including extreme wet months. It follows, then, that the seasonality plots show that winter and spring precipitation changes are projected to be larger than summer and autumn changes. Drier months are generally projected to remain about the same in terms of both frequency and rainfall level. Small decreases in extreme dry month precipitation are projected for the "hot/dry" scenario.

Climate projections can be translated into projected changes in water availability. This work will provide insight into the potential ramifications of the changing climate on water resources. Implied by the results presented here is the potential for decreased water availability due to significantly higher temperatures and evapo-transpiration losses. However, clearly this dynamic would be offset to a certain extent by increased rainfall. The analysis does not explicitly project changes in the distribution of rainfall on an event basis (this is a monthly analysis), which could affect flooding potential and also the frequency and intensity of summer droughts. However, typical climate forecasts tend to suggest that increased temperatures coupled with increased

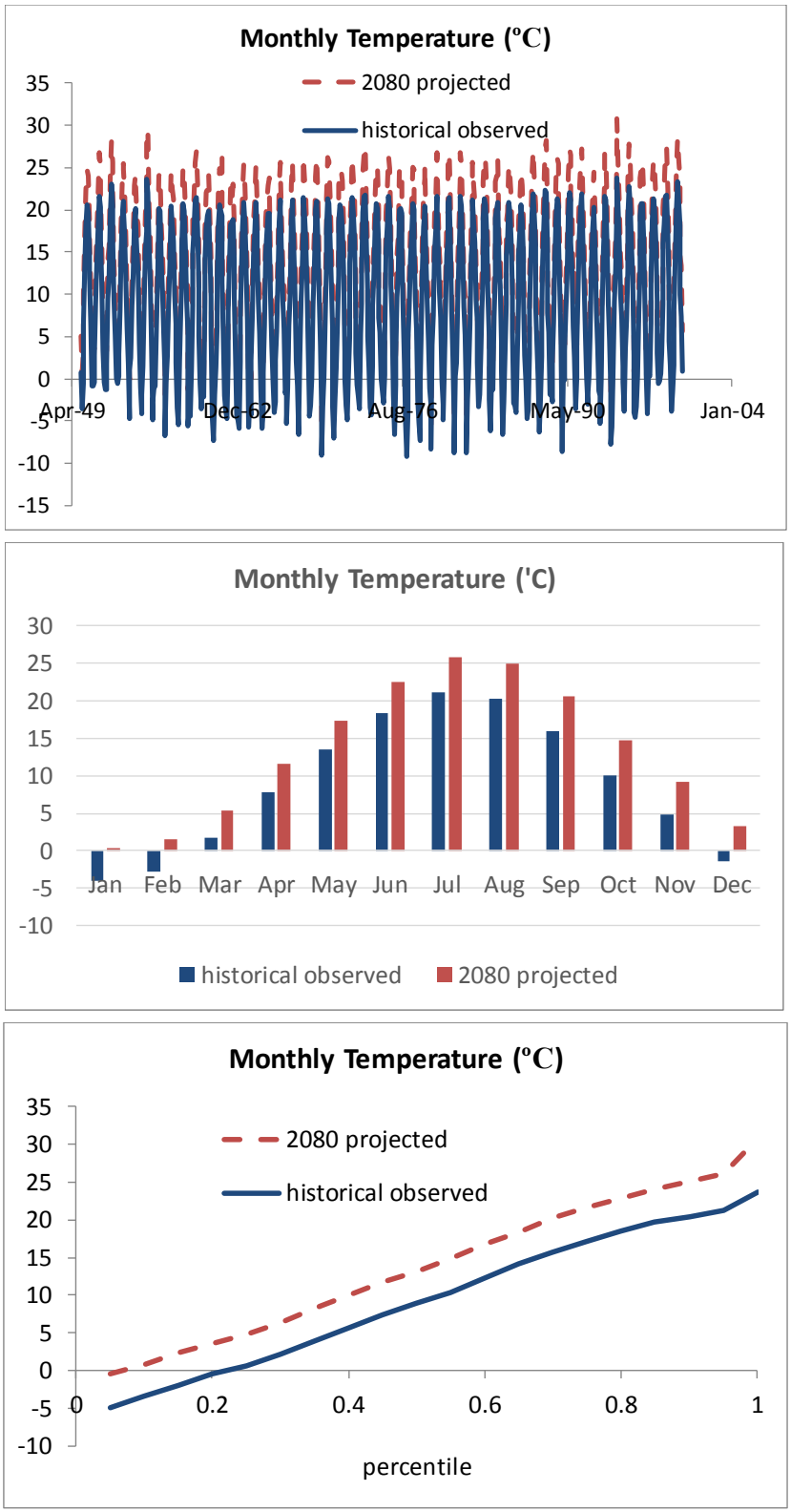


Figure 3-11. Monthly Temperature Projections: 2080 Planning Horizon, Hot Dry Ensemble

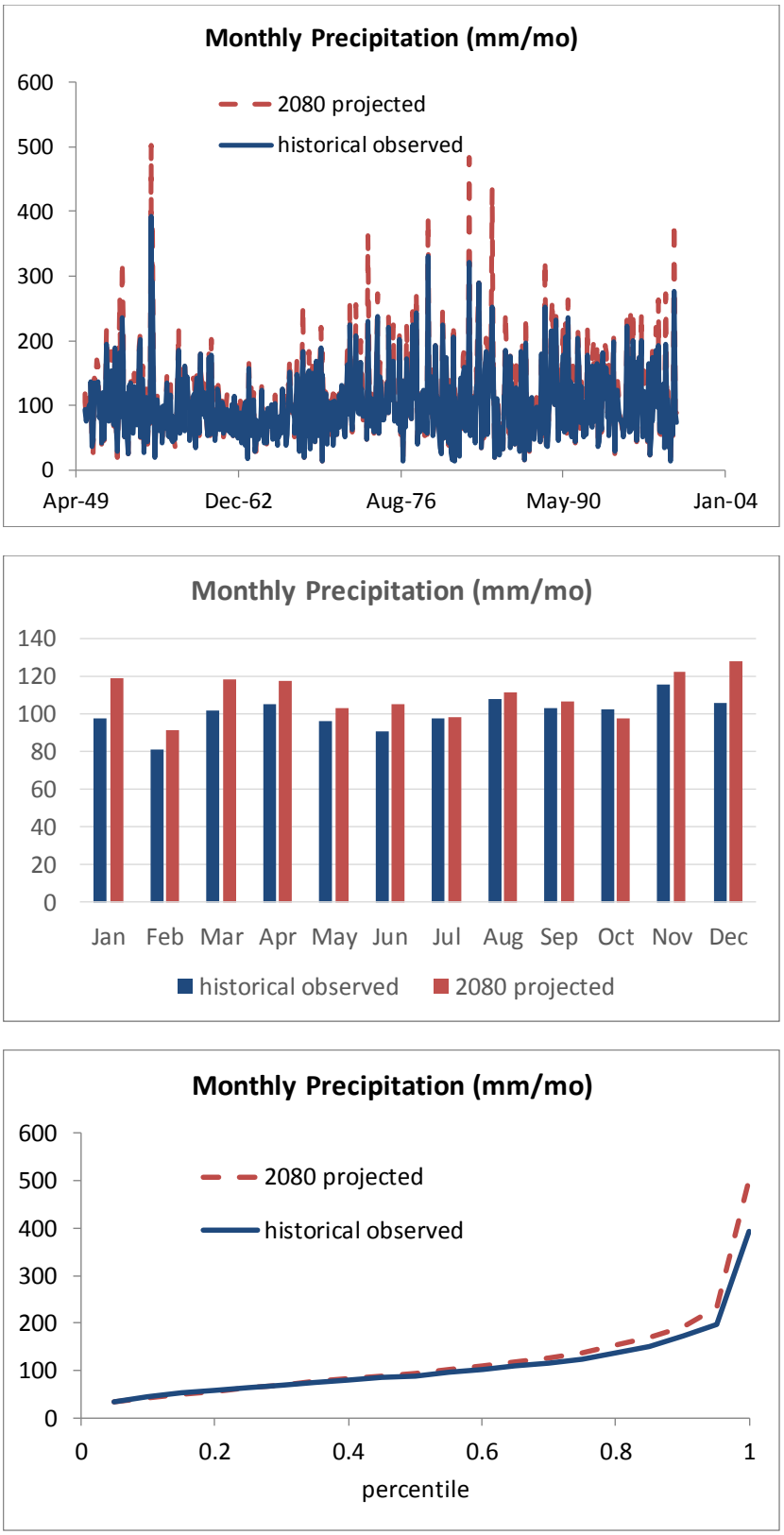
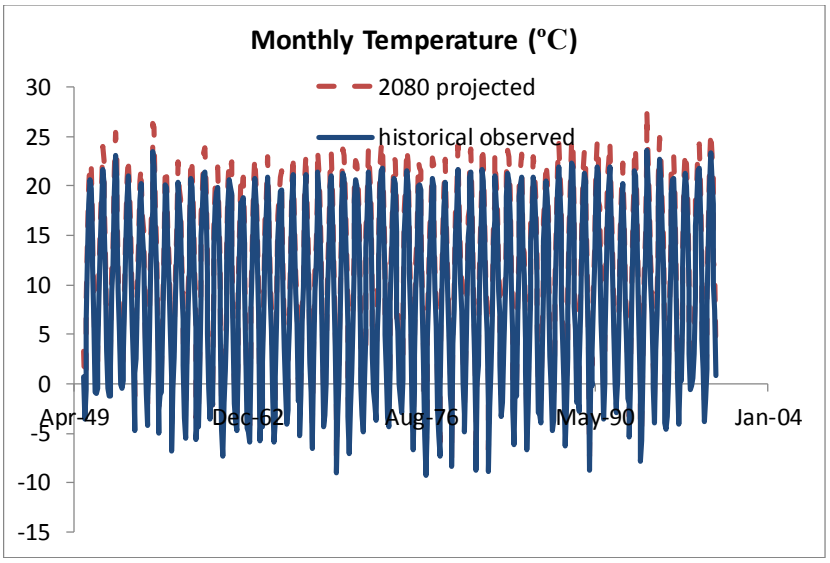
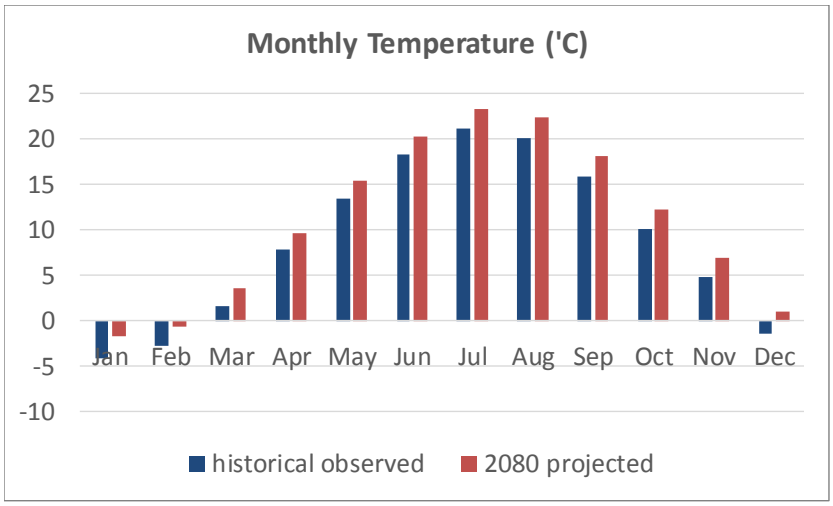


Figure 3-12. Monthly Precipitation Projections: 2080 Planning Horizon, Hot Dry Ensemble





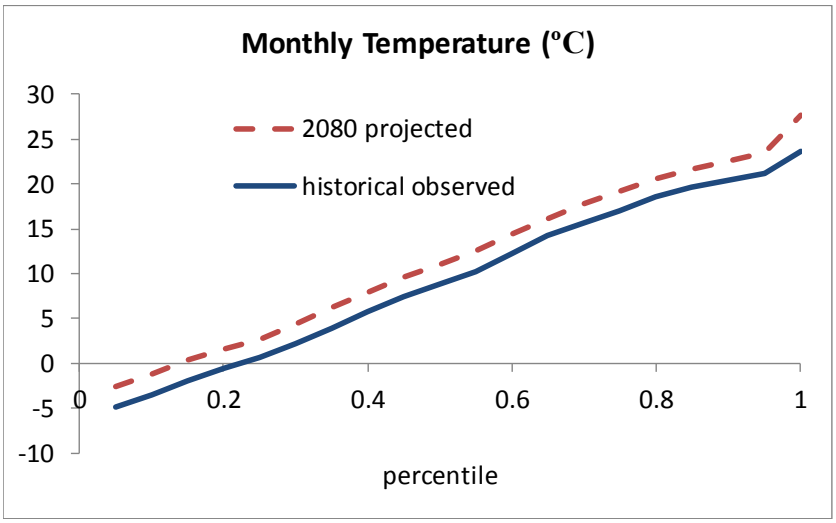


Figure 3-13. Monthly Temperature Projections: 2080 Planning Horizon, Warm Dry Ensemble

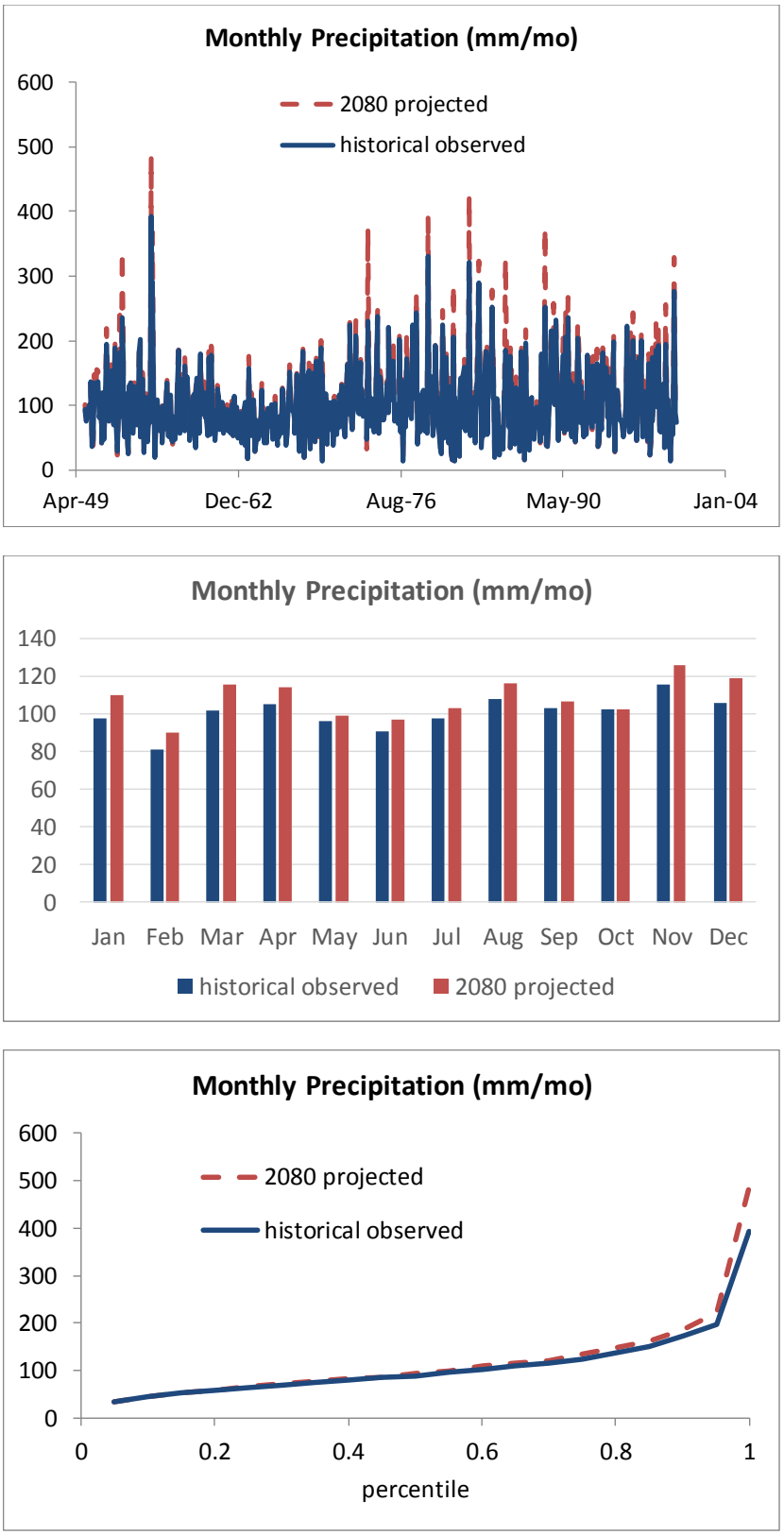


Figure 3-14. Monthly Precipitation Projections: 2080 Planning Horizon, Warm Dry Ensemble

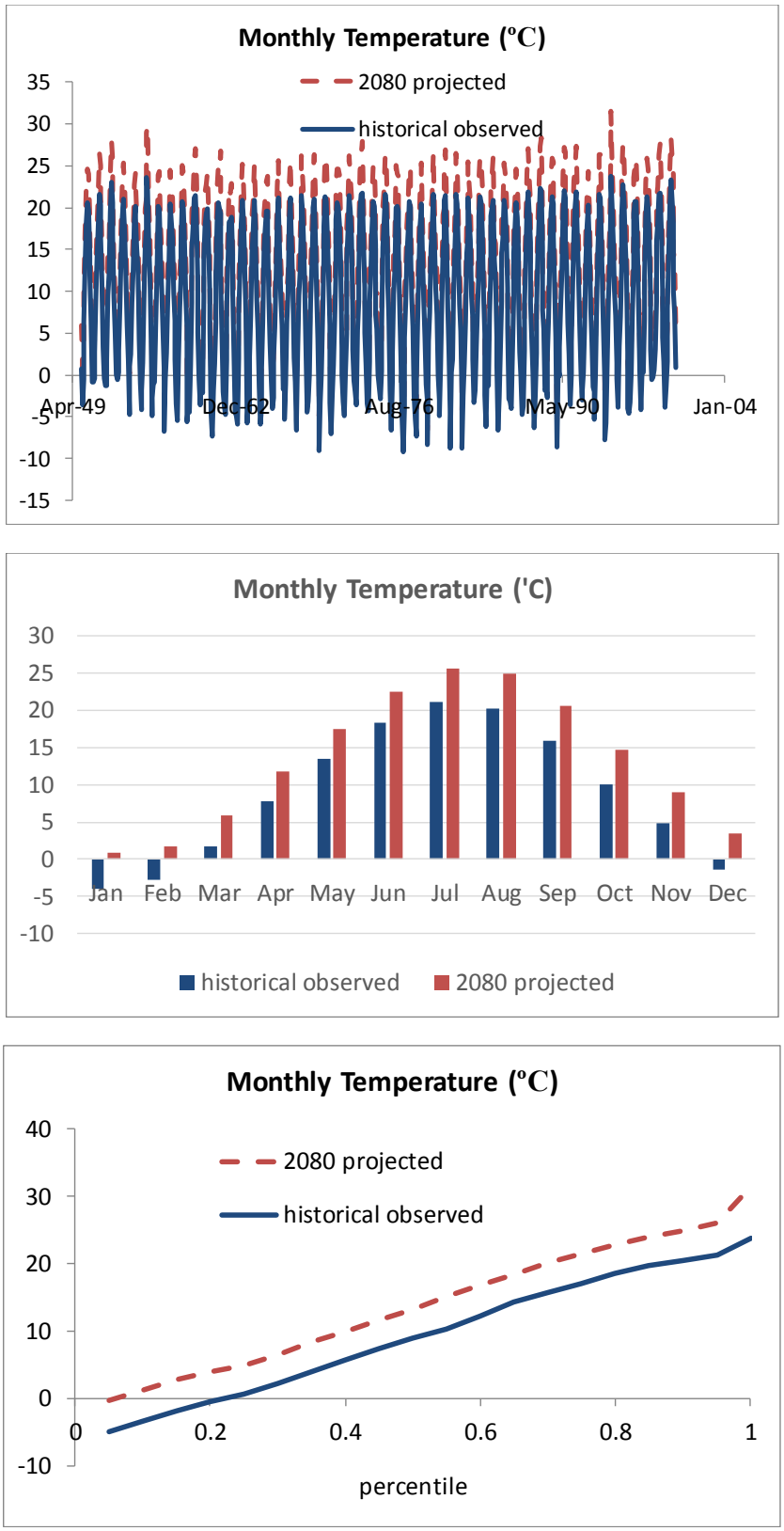


Figure 3-15. Monthly Temperature Projections: 2080 Planning Horizon, Hot Wet Ensemble

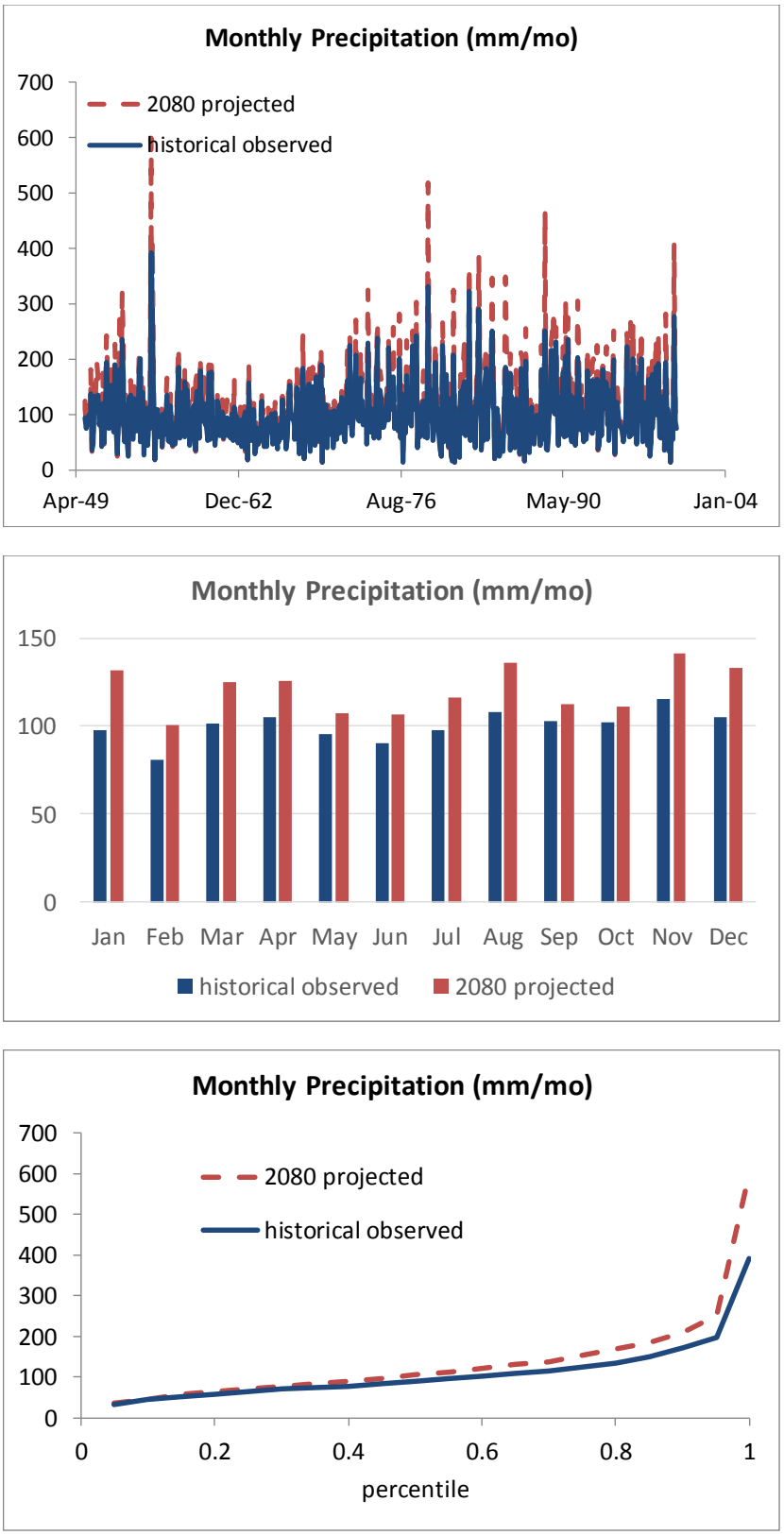
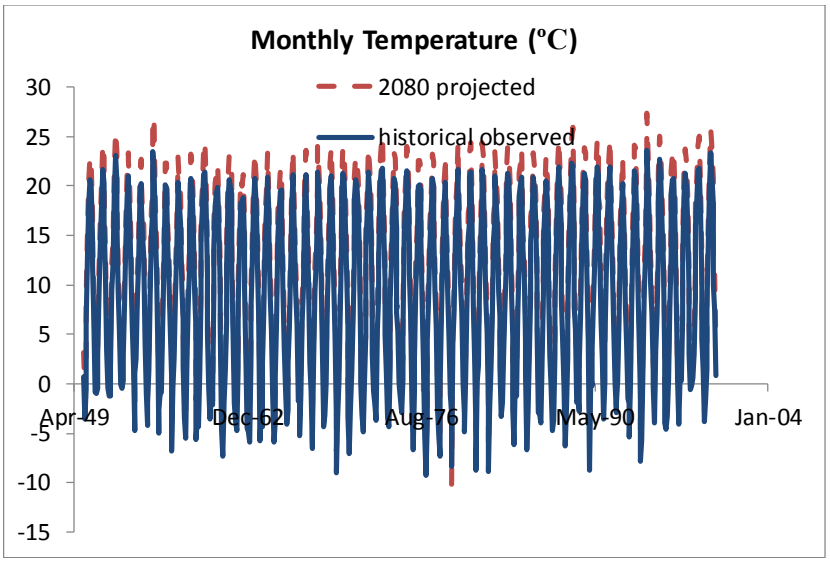
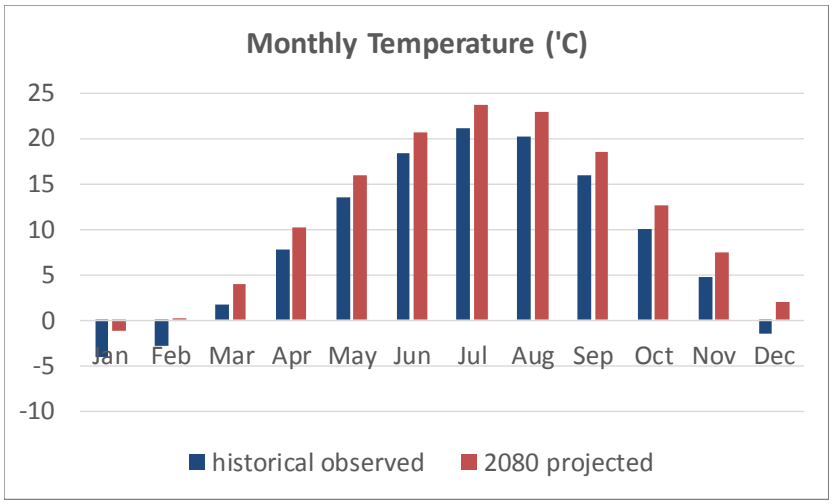


Figure 3-16. Monthly Precipitation Projections: 2080 Planning Horizon, Hot Wet Ensemble





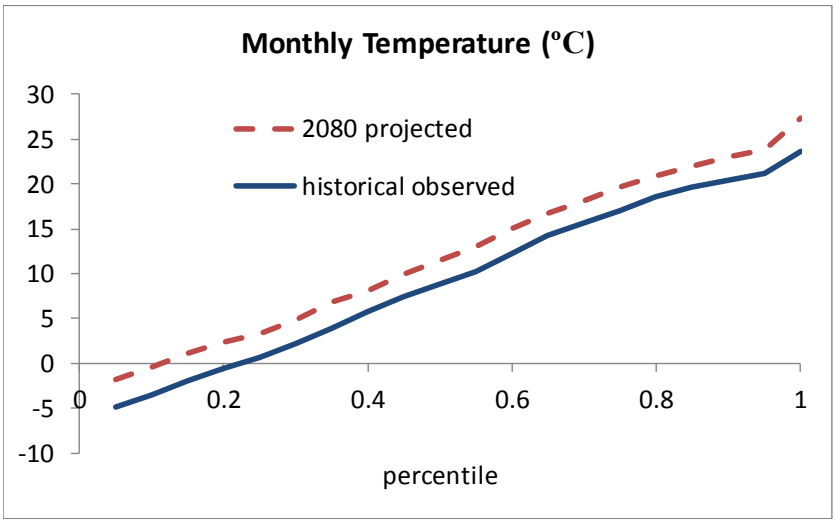


Figure 3-17. Monthly Temperature Projections: 2080 Planning Horizon, Warm Wet Ensemble

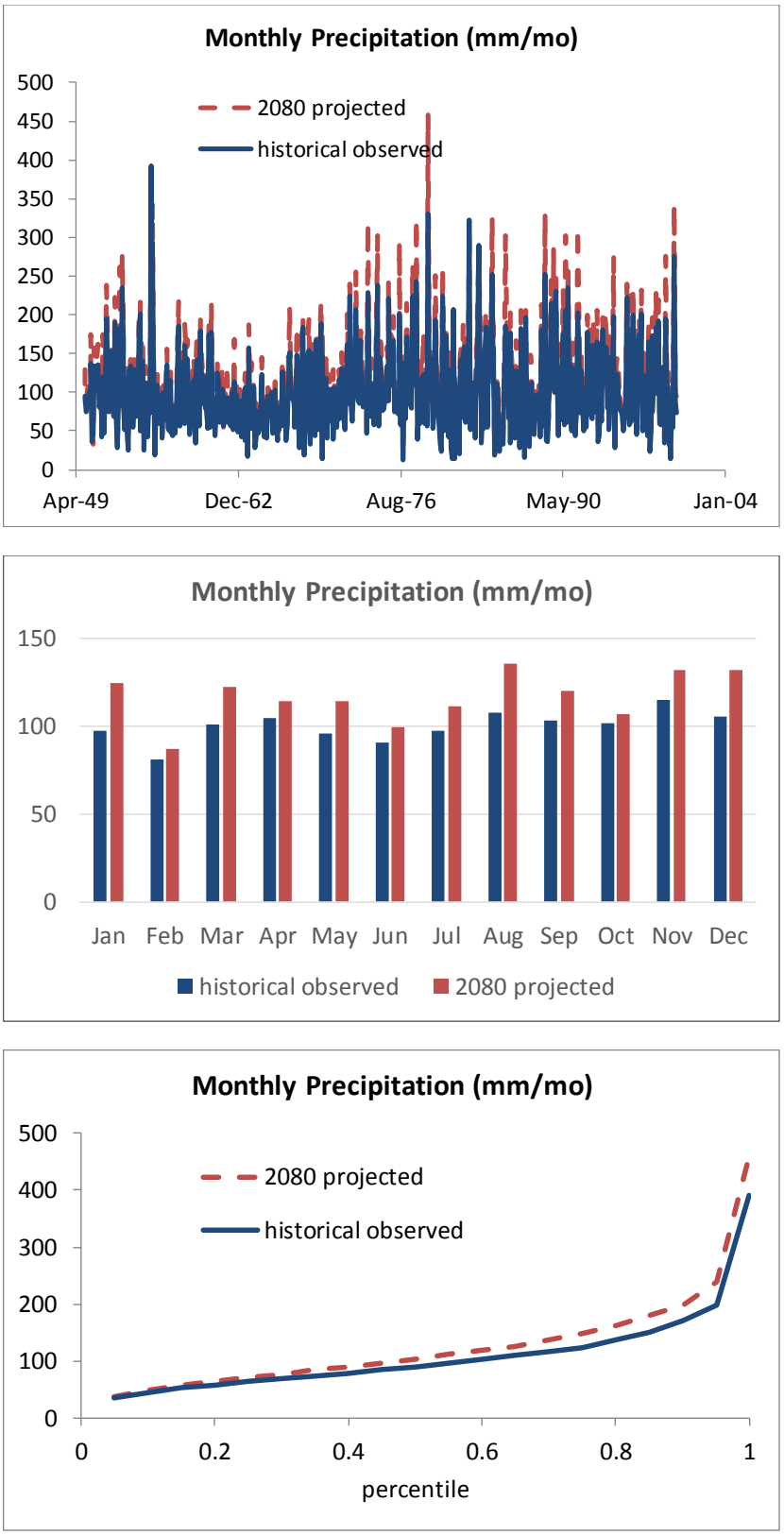


Figure 3-18. Monthly Precipitation Projections: 2080 Planning Horizon, Warm Wet Ensemble

annual precipitation generally correspond to higher intensity storms (greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts). Because Connecticut has so many small reservoir systems, these systems could be very sensitive to such changes, and case study examples may be advisable in the next phase of work.

Demands could similarly be impacted, with increasing demands due to higher temperatures, but with changes tempered by increased rainfall. The timing of water availability and stream flows will also undoubtedly be impacted, with less snow pack and earlier melt. The combination of potential rapid snow melt and higher extreme precipitation events could translate to an increased flooding risk. Lastly, river water quality could be negatively impacted by the higher temperatures; higher water temperatures can lead to increased growth rates of both algae and bacteria, and lower dissolved oxygen saturation levels.

The results presented above generally agree with other studies that have been done on potential future climate trends in Connecticut. In 2010, a report was issued by Climate Change Connecticut[9] that suggested the following summary conclusions:

a) Connecticut could see a temperature increase of 4 – 7.5°F by end of the 21st century.
b) Precipitation in Connecticut could increase by 5-10% by end of the century, and redistribute itself so that more of this increase occurs during winter months.
c) Sea-level rise may increase 12-23 inches by the end of the century.
d) Drought frequency may increase as well as duration and intensity.

Findings (a) and (b) generally agree with the range of potential conditions presented in the analysis above. Finding (c), regarding sea level rise, is an important consideration for Connecticut's coastal areas that is not addressed by the methodology used in this report. Finding (d), on drought frequency and intensity, while seemingly contradictory to the prediction of more overall rain, supports the notion that the distribution of rainfall may change significantly (more rain in winter, less rain in summer), causing more frequent dry periods during the warmer months, where the impacts of drought can be exacerbated by increasing temperatures and resulting evaporative losses from water bodies and soil moisture.

As summarized in Section 3.1.4.1, climate forecasts typically extend 50-100 years, which exceed the 25-year planning horizon for the Plan. Climate will have impacts in the years and decades beyond the Plan's planning horizon, and future analyses should include such considerations.

3.1.4.4 Climate Change Impacts on Streamflow

Objectives

The objective of this task was to translate the climate change projections described above into projections of streamflow for the 44 regional planning basins across the state. These hydrologic

[9] Climate Change Connecticut. 2010. "The Impacts of Climate change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health" A Report by the Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf

projections are desired to provide insight on the range of potential changes in surface water availability, and in timing of delivery, across the state. The projections were specifically constructed to provide for easy input into subsequent analyses, modeling, and graphical comparisons.

Methods

The same hybrid delta ensemble (HDe) method used to project climate variables, as described above, was also applied here to generate hydrologic projections. In this method, existing recent historical flow records were modified to reflect climate change projections associated with a specific planning horizon. For this exercise, a 2040 planning horizon (± 10 years) was selected, to align with previously developed water demand projections. Instead of precipitation and temperature projections, the approach applied here used published "gridded runoff" projections from essentially the same set of GCMs as above. Note that because this analysis only focused on projections through year 2040, and not 2080 as described in the previous section, relatively smaller changes are expected. The source of these runoff projections is also the same as above (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html). Gridded runoff projections were developed by this consortium by routing 2040 precipitation and temperature projections through a macroscale rainfall-runoff model – the Variable Infiltration Capacity (VIC) model. These runoff projections can be viewed as a surrogate for projected changes in surface water availability and flow rates. More information on the gridded runoff projections and the VIC modeling can be found at: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/techmemo/BCSD5HydrologyMemo.pdf.

As recommended in the above cited report, the gridded runoff projections were used within a "delta" method, whereby only projected *changes* in surface water flow rates (as monthly depths) were used to modify streamflow records. By using runoff change factors (modeled future vs. modeled past), within the HDe method, the impacts of any residual bias in the projections are minimized. Also, as described above, historical observed patterns of flow variability are retained in future projections. Additionally, within this method, the magnitudes of the applied change factors vary across a full distribution of percentiles, resulting in a more accurate reflection of the patterns of variability in the GCM projections. The selected change factor for each month in the adjusted record is based on the relative percentile value of the given month's observed streamflow record. High flow months are adjusted using change factors associated with projected high flow conditions and low flow months adjusted with change factors associated with projected low flow conditions. Note that the model hind cast period used for the calculation of change factors again corresponds to the 1950 – 1999 period. This is the model "overlap" period used by the USBR consortium to guide model downscaling and bias correction. For further details on the HDe method, the reader is again referred to Appendix F.

The same centrally located GCM grid cell shown in Figure 3-9, and used in the climate parameter projection exercise described above, was used for this analysis. Climate model projections for this grid cell were used to modify streamflow records for the 44 regional planning basins. Underlying this approach is the assumption that climate change projections for this central location are relevant to, and representative of, locations anywhere in the state. To verify this assumption, climate projections for four corner grid cells (**Figure 3-19)** were compared, on an annual average basis, to the central grid cell. Results of this verification exercise are provided below (**Figure 3-20**). Based on this analysis, the grid cells were deemed to be adequately correlated.

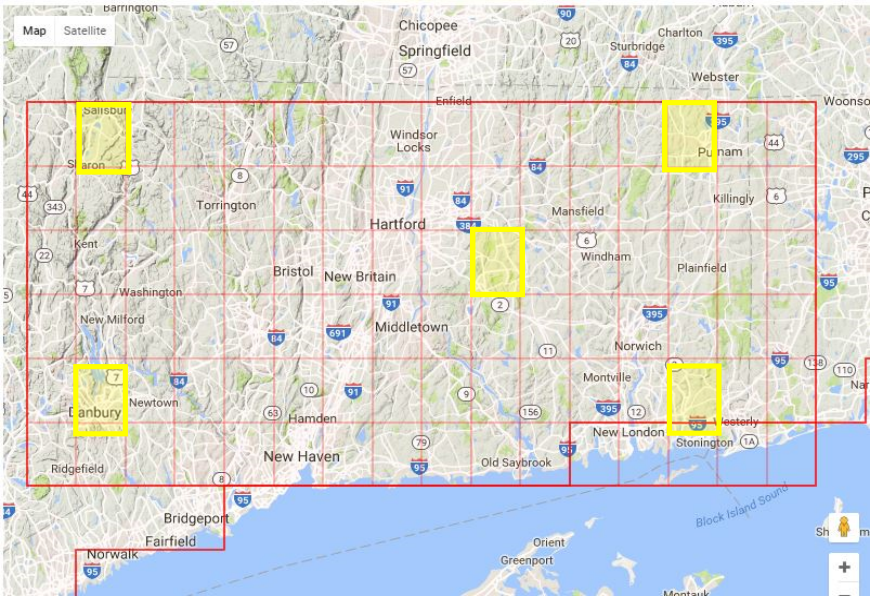


Figure 3-19. GCM Grid Cells Used in Spatial Comparison

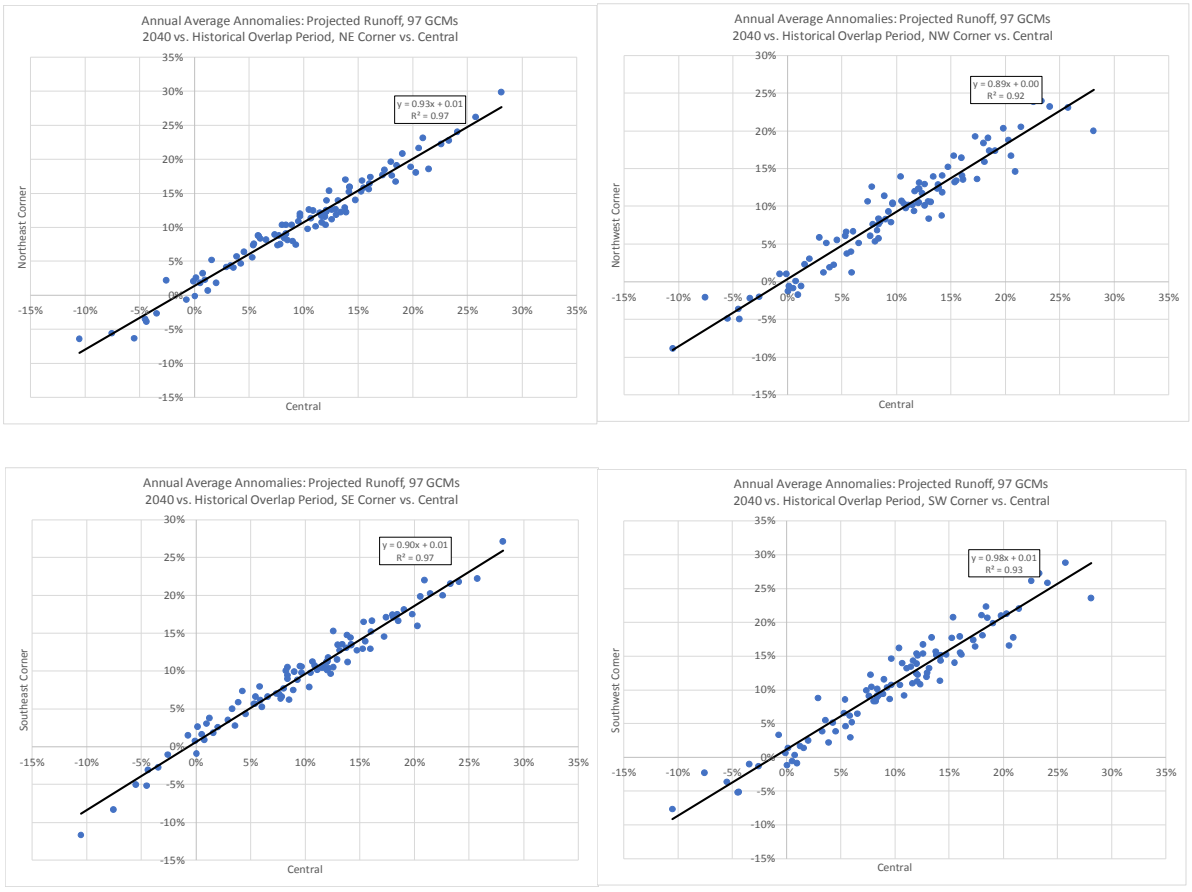
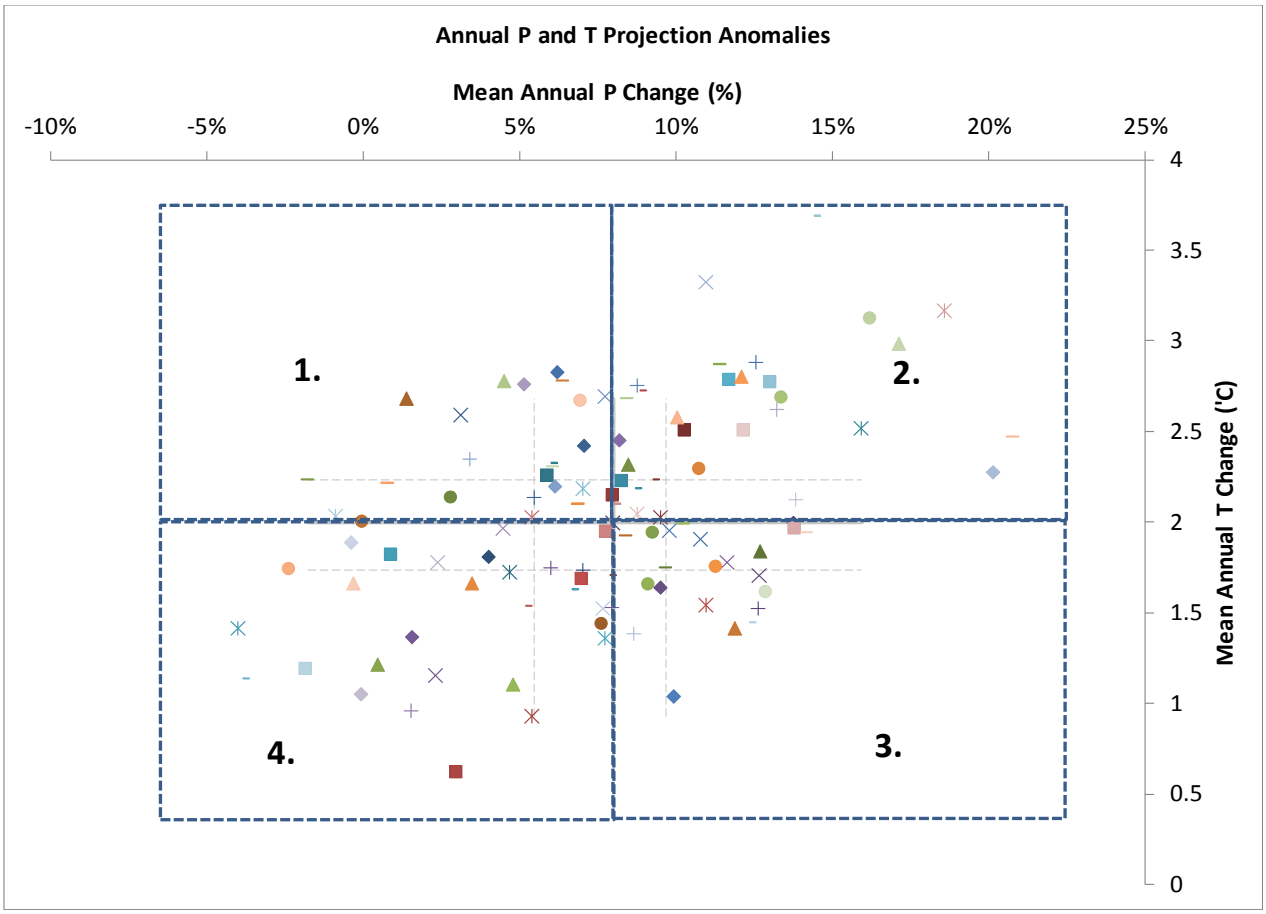


Figure 3-20. Grid Cell Comparisons: Assessment of Spatial Variability in Connecticut Gridded Runoff Projections



Climate Scenarios: (1) hot/dry, (2) hot/wet, (3) warm/wet, (4) warm/dry

Figure 3-21. Annual Anomalies (2040 vs. historical) of GCM Temperature and Precipitation Projections, with Designated Scenario Ensembles (each symbol represents a different climate model projection set)

Results

Results of this analysis, including all 176 projected monthly flow traces, are provided in Appendix F. For each of the basins and each of the four climate scenarios, projected average monthly flows are higher compared to the historical observed record. This is not surprising given the results shown in Figure 3-21, where the vast majority of 2040 climate projections indicate an overall increase in annual precipitation compared to the model hind cast period. While it is safe to assume that evapotranspiration (ET) rates will increase in the future due to higher temperatures (and are modeled as such), it appears that these increases will be largely offset by increases in precipitation.

Consistently, across all basins, the hot/dry ensemble projects the lowest average streamflow while the hot/wet ensemble projects the highest. The largest increases in streamflow are generally projected for the winter months (Dec - Feb), for all four climate ensembles. This is likely attributable to a combination of both greater winter precipitation and reduced snow accumulation. With respect to the latter, this same dynamic may be implied in the spring time results (Mar – May), where flows are generally projected to increase only slightly or to decrease

fairly significantly. Warmer winter temperatures will equate to reduced snow fall and accumulation and consequently less spring melt.

For the hot/dry scenario, flows are generally projected to decrease for nearly all non-winter months, for all basins. These reduced spring, summer, and fall flows, however, are more than offset, in terms of their impact on annual totals, by large increases in winter precipitation and runoff. Percentile analysis indicates that the largest flow months will increase by the greatest amount; while many projections indicate that lower flow months will experience a significantly smaller increase, if at all. Extreme low flows are projected to be even lower for our planning horizon, compared to baseline, for many of the ensemble / basin combinations, particularly for the hot/dry and warm/dry scenarios.

These results in general appear to have greater ramification with respect to the seasonal *timing* of flows rather than annual magnitudes. The projections in changes in extreme events, both low and high flows, may also warrant further consideration. High flow events would best be analyzed using daily projections, which were beyond the scope of this study.

3.1.5 Additional Indicators of Potential Basin Risks

3.1.5.1 Land Use

An exploratory correlation analysis was performed to identify and evaluate correlations between land use and risk of water stress (where stress is defined in this Plan as the risk of not satisfying all instream and out-of-stream needs). The intention of this analysis is to determine whether observed correlations, such as those between land use and water quantity[10], are evident regionally in Connecticut and to screen factors that warrant additional study. A strong correlation between variables can indicate the expected direction of change of one variable associated with another but cannot be used to identify the cause of the relationship, for which additional research and analysis is needed.

Data Collection, Processing and Statistical Methods

Land use data was obtained from the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database[11] (NLCD 2011). This is a widely-used dataset that characterizes land cover by 20 categories across the United States. The land use data shown in **Figure 3-22** was processed in ArcGIS using the Spatial Analyst Toolset prior to the correlation analysis. The 20 land use categories were combined into 7 classifications of land use based on category similarities. The simplified categories are Water, Developed, Barren, Forested, Shrubs and Grasses, Agricultural, and Wetlands. Impervious surface percentage was also included in this analysis.

For the correlation analysis, the instream and out-of-stream water needs as a percent of streamflow was used as an indicator of risk of water stress, for both current and future average

[10] Bjerklie, D.M., Starn, J.J., and Tamayo, Claudia. 2010. "Estimation of the effects of land use and groundwater withdrawals on streamflow for the Pomperaug River, Connecticut" U.S. Geological Survey Scientific Investigations Report 2010–5114. http://pubs.usgs.gov/sir/2010/5114.

[11] Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing*, Vol. 70, No. 7, July 2004, pp. 829-840. https://www.mrlc.gov/nlcd11_data.php.

annual and peak summer conditions (see Sections 2.1 and 3.1). It should be noted that there are several limitations with this correlation analysis. The water in basin volumes presented in the Plan do not necessarily reflect the total impact to summer base flow due to loss of infiltration/recharge from impervious cover. Secondly, water used in urbanized areas with high impervious cover often comes from a different, and often less developed basin, so there may be very little in the way of out-of-stream withdrawals in the urbanized areas.

Two common measures of linear association were considered in this analysis, Pearson's *r* and the coefficient of determination (R^2). Pearson's *r* indicates the strength and direction of a linear relationship between variables[12]. A value of +/- 1 for r indicates a perfect linear correlation and a value of 0 indicates no correlation. Absolute values greater than 0.7 are generally considered strong correlations. Correlations with p-values less than 0.05 were considered statistically significant in this analysis. Using this threshold, the probability that a stated value of Pearson's *r* is a result of chance and is not actually representative of the dataset is less than 5%.

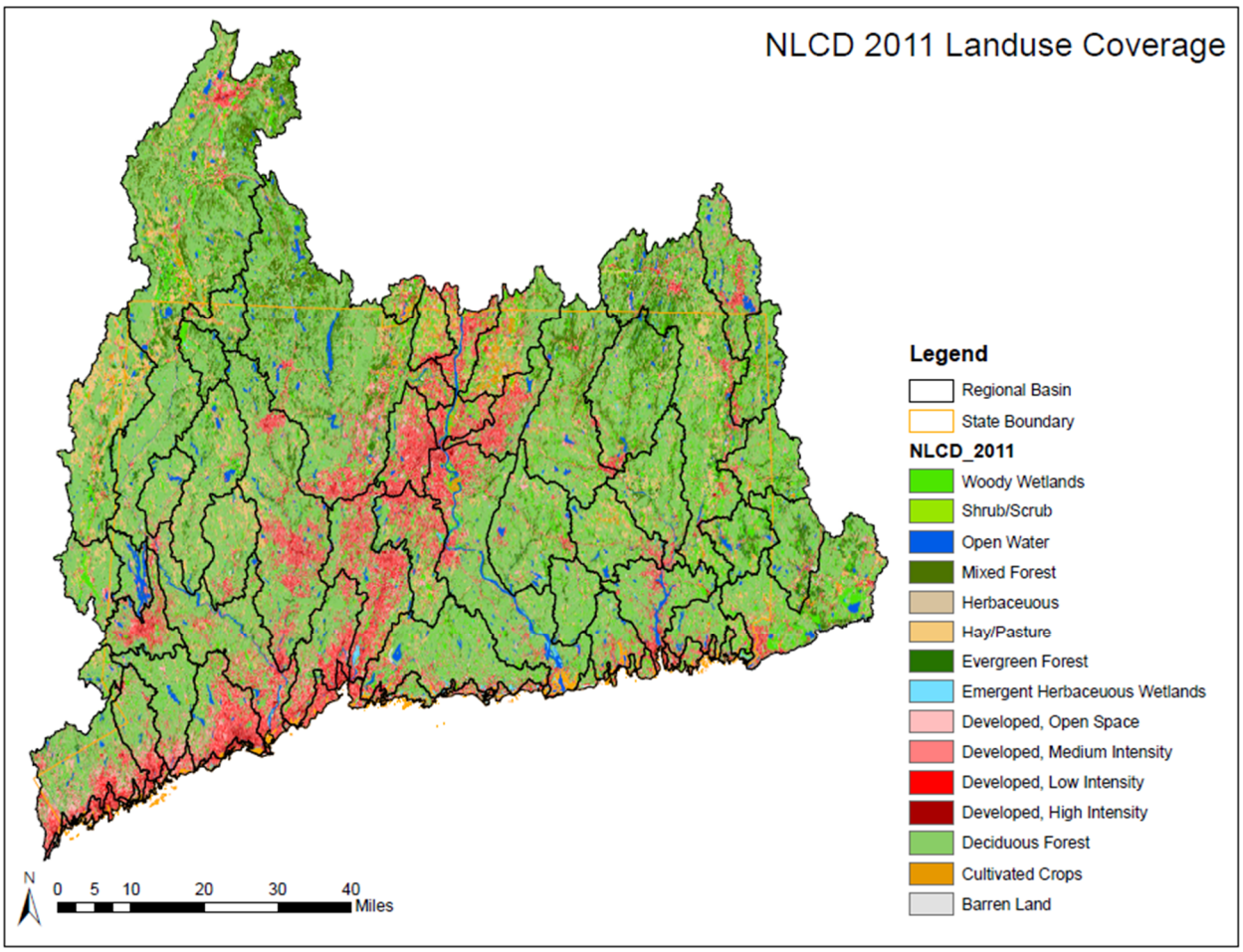


Figure 3-22. National Land Cover Database (NLCD) Coverage for Connecticut,

[12] Environmental Statistics: Environmental Quality - Engineering and Design (EM 1110-1-4014). U.S. Army Corps of Engineers. http://app.knovel.com/hotlink/toc/id:kpESEQEDEA/environmental-statistics/environmental-statistics

In linear regression, R^2 measures the amount of variance explained by the model and is widely used as a measure of the strength of relationships between variables. An R^2 value of 1 indicates perfect predictive power, all variation from the mean is represented by the model, whereas a value of 0 indicates no predictive power. For this analysis, land use was tested as an explanatory variable for risk of water stress (*y*). All statistical calculations were performed using the R software package[13].

Results and Discussion

Recall that for the purposes of this analysis, water "stress" is defined as the risk of not satisfying all instream and out-of-stream needs. Most land use categories exhibited no correlation with risk of water stress. All R^2 values for all relationships were very low, indicating that most of the variance in the observations is not reflected adequately by linear models. The low R^2 values also demonstrate the lack of a clear relationship between these land use categories and risk of water stress. The Pearson's *r* values were statistically significant for the developed, impervious, wetland and agriculture land use categories. The correlations between risk of water stress and these 4 categories for current and future average annual and July conditions are shown in **Figure 3-23.**

Weak positive correlations to risk of water stress were demonstrated in both the total developed and impervious area categories. The positive correlation between risk of water stress and total developed area is likely the result of increased demand on water supplies by municipal and industrial users in more developed regional basins. The positive correlation between risk of water stress and impervious area could be the result of a similar effect. Increased impervious surfaces, often associated with development, may increase the percentage of precipitation leaving a watershed as runoff due to decreased groundwater infiltration and increased routing of water through drainage systems. This may reduce available water supply and increase risk of water stress. Although these correlations and suspected drivers are intuitive, additional study is needed to definitively identify and describe these relationships and interactions. It is important to note that risk of water stress in this example does not include water quality stress. Highly developed areas and large amounts of impervious surface are commonly associated with reductions in water quality. However, as previously noted, water sources are often not located in the same basin as development.

Total wetland and agricultural area showed weak negative correlations with risk of water stress. Wetlands typically slow the routing of water and might increase available supplies by increasing groundwater infiltration. The increased percentage of wetland area protected under the Clean Waters Act limits development of watershed areas, which could decrease regional water demand. In contrast, the decrease in risk of water stress with an increase in agricultural area seems counter-intuitive. Agriculture typically represents high-demand water users. Possible reasons for the negative correlation could be that many crops in Connecticut are types that require less water, a significant proportion of the area classified as agriculture is not currently in production,

[13] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

or the correlation was skewed by extreme values and is not representative of actual conditions. These negative correlations may warrant additional study.

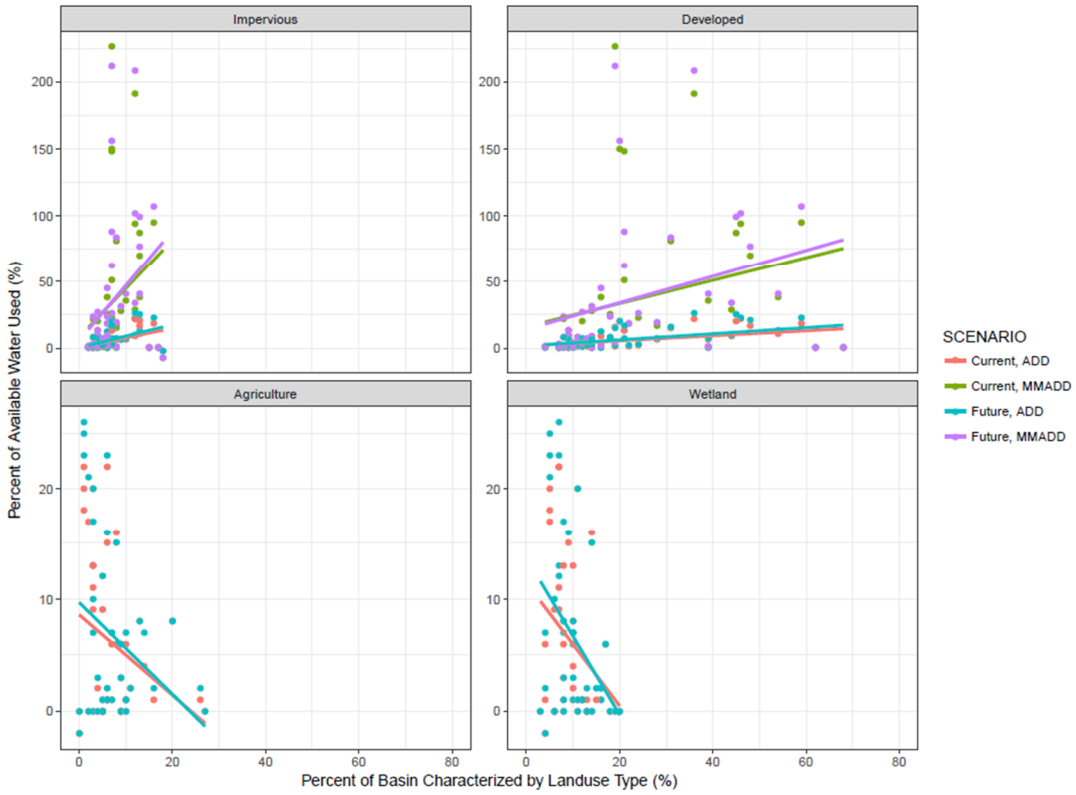


Figure 3-23. Statistically-Significant ($p < 0.05$) Correlations of Land Use and Risk of Water Stress for Current and Future Average (ADD) and Monthly Maximum (MMADD) Conditions

3.1.5.2 Seasonal Water Use Patterns

A similar analysis was performed to identify and evaluate possible correlations between seasonal water use patterns and risk of water stress. Peaking factors for water utilities, as available from WUCC Preliminary Water Supply Assessments, were used. Peaking factors represent the ratio of peak summer month demand to average annual demand. For this analysis, available peaking factors were averaged by regional basin. A similar statistical analysis was performed as previously described for the land use correlation analysis.

Results and Discussion

The results of the correlation analysis between peaking factors and percentage of out-of-stream uses indicates that most of the variance in the observations is not captured in a linear model, as also demonstrated in the land use correlations. In all cases, the R^2 values for all relationships are low. The high variation in extreme values, notably in maximum monthly use (**Figure 3-24**), lowers the R^2 values. To account for this, Pearson's *r* provides a better indication of correlation.

There is a slight positive trend in out-of-stream use with increasing peaking factor. The peaking factors show statistically-significant positive correlations (Pearson's *r*) with almost all water-use scenarios considered (current and future average and maximum monthly conditions). This indicates that an increase in peaking factor is likely to correspond to an increase in total out-of-

stream water use. For the maximum monthly scenarios, where a higher peaking factor is directly related to an increase in out-of-stream use, this correlation is intuitive. The decrease in the strength of the correlation for future conditions may be the result of the projected decrease of demand from population decline. When considering the results of this analysis, it is important to note that water sources are not always located in the same basin as the demand for water.

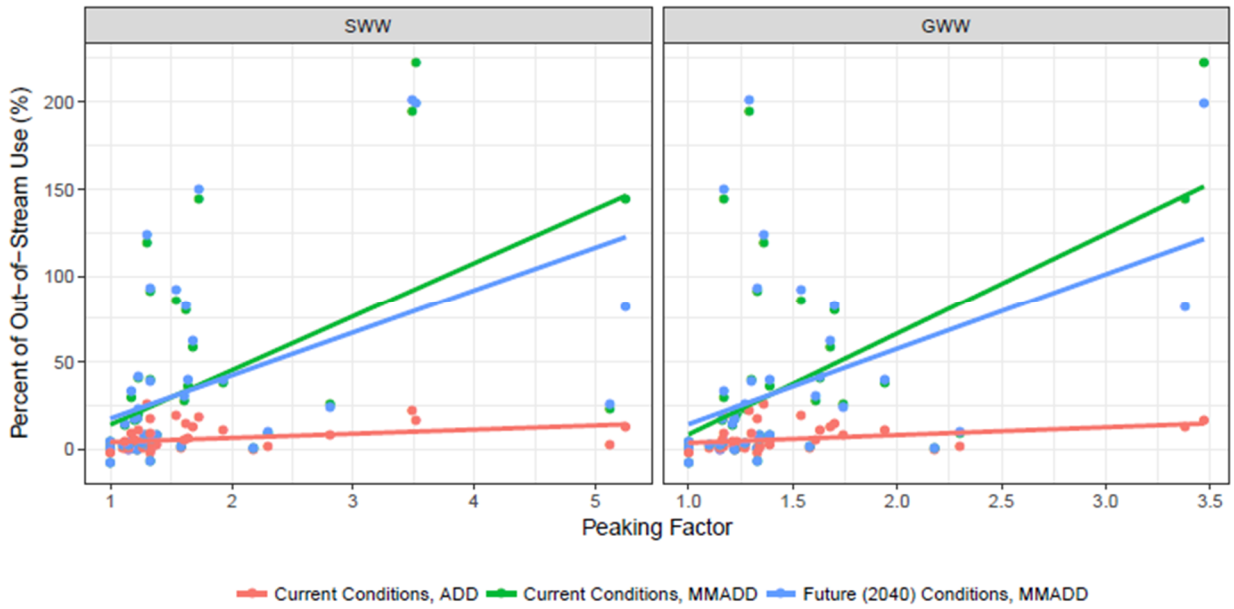


Figure 3-24. Statistically-Significant ($p < 0.05$) Correlations of Peaking Factor and Out-of-Stream Water Use for Current and Future Average (ADD) and Monthly Maximum (MMADD) Conditions

3.1.6 Simulating Management Approaches to Guide Decisions – A Demonstration

3.1.6.1 Water Allocation Model

The water inventory and comparisons of water availability to water needs at the regional basin scale is a useful screening tool to identify gaps. To effectively identify the nature and location of potential future shortages and evaluate appropriate operational strategies and management approaches necessary to reduce or eliminate the gaps, more detailed analysis is necessary. Water allocation models are often used to address this need at a regional or sub-regional basin. Water allocation models have previously been used in Connecticut to evaluate reservoir yield and propose operational strategies for increasing environmental flows without jeopardizing water supply reliability.

To demonstrate the application of a water allocation model, a simple model of the Quinnipiac regional basin was developed following discussions with the Science and Technical Subcommittee and stakeholders within the basin. The Quinnipiac regional basin consists of a completely in-state major river system, contains several USGS streamflow gages, has multiple major water users and wastewater discharges, and several reservoirs – making it an ideal basin to demonstrate the potential benefits of water allocation modeling to study the impacts of future water management strategies as suggested by the policy recommendations in this report. *The model was developed*

for demonstration purposes only, and the results should be viewed as examples of how management strategies can be evaluated, and not as an endorsement of any particular strategy for this basin.

CDM Smith's Simplified Water Allocation Model (SWAM) was used to simulate the basin. SWAM was originally developed to address an identified need for a networked generalized water allocation modeling tool that could be easily and simply applied for planning studies by a wide range of end-users. Like most water allocation models, SWAM calculates physically and legally available water (water that flows or occurs, and allowable withdrawals or uses of such water, respectively), diversions, storage, consumption, and return flows at user-defined nodes in a networked river system. A range of water user types can be represented in the model, including municipal water suppliers, agricultural irrigators, and industrial water users, with time-variable demands either prescribed by the user or, in some cases, calculated internally. SWAM can simulate either a "prior appropriations" system of water rights or a "riparian" water rights system, as set by the model user. Additional features in the model include easily-parameterized municipal and industrial (M&I) conservation and reuse programs, agricultural land transfers, groundwater pumping, alternative source evaluation, and transbasin diversion projects. The model user chooses the appropriate level of complexity given the modeling objectives and data availability.

A water allocation model such as SWAM could provide valuable information on which to make decisions. Although data needs and application of the model are very straightforward, training is necessary to use the model appropriately. Therefore, a mechanism needs to be in place to provide this training. A "train the trainer" program would be an effective way of creating a cadre of people who could do allocation modeling at whatever scale was appropriate for a particular problem.

3.1.6.2 Model Development

A typical SWAM model consists of a user-constructed network of streams, water use nodes, and reservoirs, in which reach element is referred to as model "object." Each object has its own set of equations and calculations, where relationships between objects are specified through the individual objects themselves and user-specified relative mile markers. SWAM object inputs include unimpaired flows (UIFs); reservoir characteristics such as operating rule curves, storage-area-relationships, and evaporation rates; and water user information, including withdrawals, out-of-stream use, and return flows. The Quinnipiac River model framework, as shown in **Figure 3-25**, was developed to include all reservoirs and tributaries with current, significant permitted or registered withdrawals and discharges. The model framework was developed with input from the Science and Technical Subcommittee and basin stakeholders (via Milone and MacBroom). The assumptions behind the model tributaries, reservoirs, and other objects are presented in the following sections.

3.1.6.3 Representation of Tributaries

The model simulates historic hydrologic conditions from 1988 through 2016 based on the available period of record of USGS streamflow gages in the basin. The primary hydrologic inputs to the model are unimpaired flows for each tributary object. These flows, entered as a continuous timeseries of monthly and daily average data, represent flow at the top of each tributary object reach. In SWAM, mainstem gain/loss factors and tributary subbasin flow factors capture ungaged flow gains and losses associated with increasing drainage area with distance downstream and/or

interaction with subsurface flow. The gain/loss and subbasin flow factors are applied to the input headwater flows and represent a steady and uniform gain/loss percentage relevant to the designated reach. Actual flow volume changes are calculated for a specific location based on these reach-specific factors and in proportion to stream length and the object headwater flow for the given timestep.

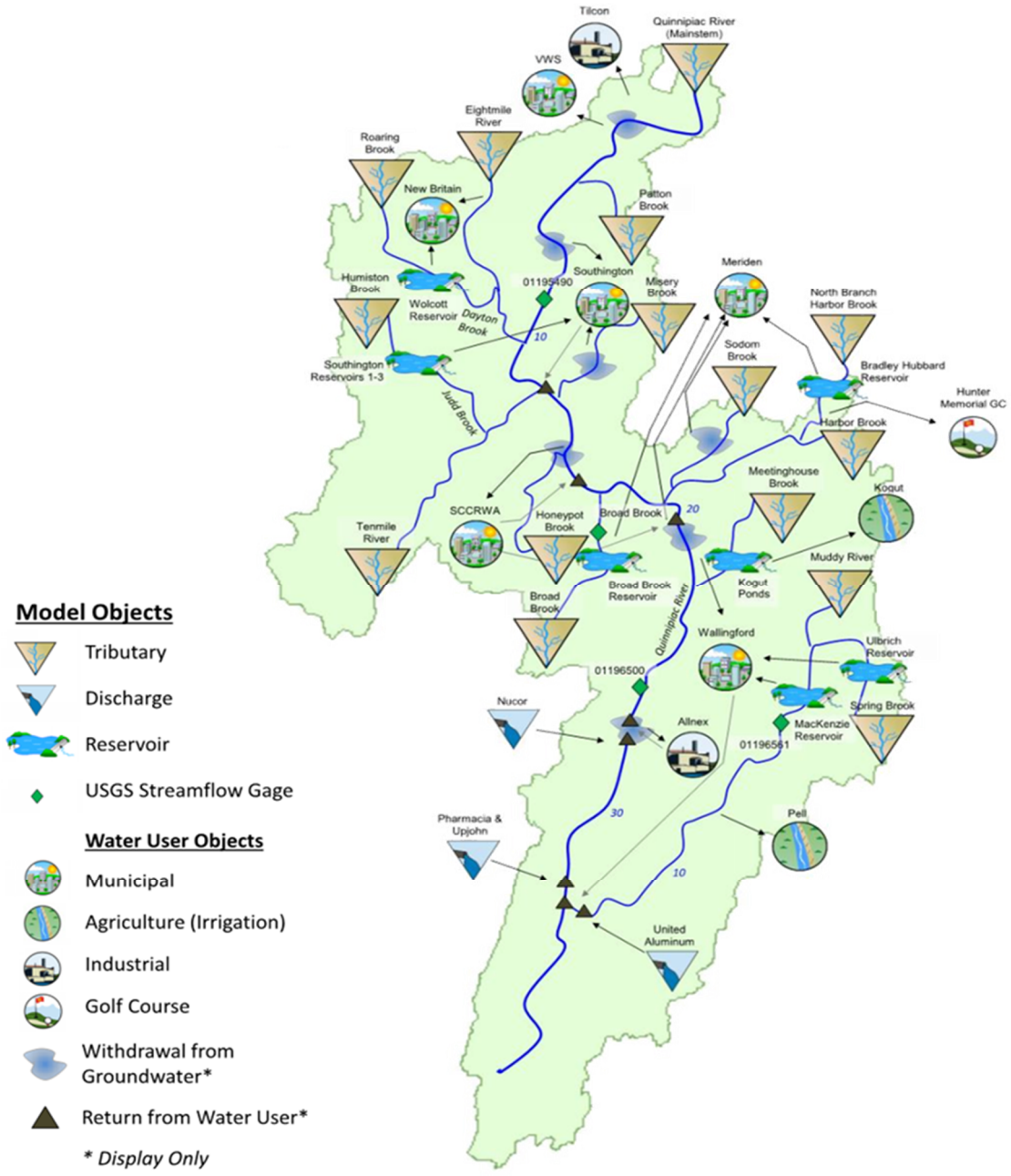


Figure 3-25. Quinnipiac Model Framework

Table 3-9 lists the model tributaries and which USGS streamflow gages were used to create the headwater flows. Except for the model's mainstem, the Quinnipiac River, these tributary flows were estimated either from the gage on the Salmon River near East Hampton, CT (01193500) or Bunnell Brook near Burlington, CT (01188000). Both gages are classified as "reference" by the USGS, meaning they are unaffected by artificial diversions, storage, or modifications in or on the natural stream channels of the watershed, and therefore appropriate as a source for estimating ungaged flows. Estimation of headwater flows comes from an area proration of a designated small headwater area for each respective tributary to the area of the selected reference gage. Headwater flows for the model's mainstem were developed using the gage flow from the Quinnipiac River at Southington, CT (01195490). This gage flow was modified to an approximate unimpaired state using assumptions and estimations of past water use patterns (see assumptions for water use in Section 3.1.6.5) before being prorated back to the designated mainstem headwater area.

Table 3-9. Model Tributaries and USGS Streamflow Gages used for Headwater Flows

Model Tributary	USGS Gage ID	USGS Gage Name
Quinnipiac River (Mainstem)	01195490	Quinnipiac River at Southington, CT
Broad Brook	01193500	Salmon River near East Hampton, CT
Eightmile River	01188000	Bunnell Brook near Burlington, CT
Harbor Brook	01193500	Salmon River near East Hampton, CT
Honeypot Brook	01193500	Salmon River near East Hampton, CT
Humiston Brook	01188000	Bunnell Brook near Burlington, CT
Meetinghouse Brook	01188000	Bunnell Brook near Burlington, CT
Misery Brook	01188000	Bunnell Brook near Burlington, CT
Muddy River	01193500	Salmon River near East Hampton, CT
North Branch Harbor Brook	01193500	Salmon River near East Hampton, CT
Patton Brook	01188000	Bunnell Brook near Burlington, CT
Roaring Brook	01188000	Bunnell Brook near Burlington, CT
Sodom Brook	01193500	Salmon River near East Hampton, CT
Spring Brook	01193500	Salmon River near East Hampton, CT
Tenmile River	01193500	Salmon River near East Hampton, CT

3.1.6.4 Reservoirs

Seven reservoirs for municipal water or agricultural supply are represented in the model. The three Southington Reservoirs and Kogut Nursery's Ponds were simplified into aggregate reservoir objects. **Table 3-10** summarizes the tributary location, total capacity, surface area at full, release requirements (where present). The only reservoir with release requirements is Broad Brook Reservoir, which will ultimately follow the multi-level release rules (MLRR) based on seasonal flow criteria.

In SWAM, evaporative losses can be specified using monthly-varying seasonal rates (inches per day or percent volume) or with a user-specified timeseries of monthly or daily evaporative losses

(inches per month or inches per day). In this model, evaporative losses are specified as a monthly rate (inches per day) based on measurements from CT evaporation stations and adjusted with a 70% pan coefficient.

Area-capacity relationships are represented by a simplified tabular relationship. More complex models can include the full tabular relationship, as well as conversions from volume to elevation. SWAM treats flood flows (when reservoirs are at capacity) simply as bypass flow. Generally, flood control outflow relationships are not needed, and are not assigned.

Table 3-10. Model Reservoirs

Reservoir	Rule	Model Trib	Capacity (MG)	Area (ac)
Bradley Hubbard Reservoir	Exempt	North Branch Harbor Brook	115	35
Broad Brook Reservoir	MLRR	Broad Brook	962	290
Wolcott Reservoir	Exempt	Roaring Brook	155	54
Southington Reservoir #1	Exempt	Humiston Brook	131	76
Southington Reservoir #2	Exempt			
Southington Reservoir #3	Exempt			
MacKenzie Reservoir	Exempt	Muddy River	160	48
Ulbrich Reservoir	Exempt	Spring Brook	965	154
Kogut Ponds	Exempt	Meetinghouse Brook	19	5

3.1.6.5 Representation of Water Users and Demands

Table 3-11 summarizes the sources of supply for all Water Use objects included in the model, including withdrawal tributaries/reservoirs, subbasin location, and withdrawal type. Many public supply supplies are from near-river groundwater sources. In this case, given that there is a likely strong connection between the river and adjacent alluvial aquifer, these groundwater withdrawals are modeled as coming from the tributaries. A simplifying assumption was made that, for every 1 gallon pulled from the aquifer, 1 gallon is removed from the adjacent tributary. Demands for users can be specified either as a timeseries or a monthly average rate. Due to limited historic information, demands for users were set to a monthly average rate.

The available historic withdrawal information for major groundwater withdrawals was from 1997 to 2001, except for South Central Connecticut Regional Water Authority (SCCRWA), who provided data from recent years (2012-2016). No historic withdrawal amounts were available from surface water; therefore, reported average and maximum daily demands were used. Demands for Water Users from surface water or a combination of surface and groundwater were slightly more complicated. Using the historic groundwater values, monthly peaking factors were developed for three usage categories: municipal, irrigation (golf courses and agricultural) and mining/industrial. These factors were then applied to the available average demands, with the peak months adjusted if needed when compared to maximum daily demands. For Water Users with multiple sources, especially reservoirs, safe yields were used to proportion how demands were satisfied.

There are several instances of a community water system with withdrawals from or returns to a regional basin outside of the Quinnipiac River Basin. While SWAM has advanced features to account for transbasin relationships, for simplicity each Water User object's respective demand and out-of-stream use only reflects in-basin amounts. As some surface water users only have generalized demands and safe yield estimates available, this contributes to uncertainty in estimating demands when a user has multiple sources across basins.

Table 3-11. Model Surface and Groundwater User Objects

Model ID	Subbasin ID	System Name	Model Withdrawal Source	Withdrawal Type
VWS	5200	Valley Water Systems, Inc.	Quinnipiac River	GW
New Britain	5201	New Britain Water Department	Wolcott Reservoir/Roaring Brook	SW
	5200		Eightmile River (emergency)	SW
Tilcon	5200	Tilcon Connecticut Inc.	Quinnipiac River	GW
Southington	5202	Southington Water Department	Southington Reservoirs 1-3/ Humiston Brook	SW
	5200		Quinnipiac River	GW
	5203		Misery Brook	GW
SCCRWA	5200	South Central Connecticut Regional Water Authority	Quinnipiac River	GW
Meriden	5206	Meriden Water Department	Bradley Hubbard Reservoir/ North Branch Harbor Brook	SW
	5204		Broad Brook Reservoir/ Broad Brook	SW
	5205		Sodom Brook	GW
	5200		Quinnipiac River	GW
Wallingford	5208	Wallingford Water Department	MacKenzie Reservoir/Muddy River	SW
	5208		Ulbrich Reservoir/Spring Brook	SW
	5200		Quinnipiac River	GW
Allnex	5200	Allnex USA, Inc.	Quinnipiac River	Both
Kogut	5200	Kogut Florist & Nurseryman, Inc.	Meetinghouse Branch	SW
Pell	5208	Pell Farm	Muddy River	SW
Hunter Memorial GC	5206	Hunter Memorial Golf Course	North Branch Harbor Brook	SW

3.1.6.6 Out-of-Stream Use and Return Flows

Water and wastewater discharges can be simulated two ways in SWAM. First, they can be associated with a Water User object, each of which may specify five points of discharge anywhere in the river network. These discharges are not represented with visual model objects, but are identified within the dialogue box for the associated Water User object. Alternatively, discharges can be specified within a Discharge object. For the former, return flows are calculated via a

percent out-of-stream use value applied to the demands. The latter is simply represented by a timeseries. **Table 3-12** lists all the points of return flow in the model, with an asterisk signifying those represented by a distinct Discharge object.

Only an overall average value was available for each of these return flow locations. For the three discharge objects, the single value was simply repeated for the object timeseries. For return flows associated with Water Users, percent out-of-stream use values were estimated from SWAM default values and adjusted when appropriate based on the single available discharge value. No returns are assumed for golf course and agricultural irrigation (i.e., 100% out-of-stream use). For the instances where a user returns flows outside of a basin, SWAM simply discharges the amount to a location that does not affect basin mass balance.

Table 3-12. Model Return Flows

Model Object	Permit ID	Site Name	Avg. Discharge (MGD)	Model Tributary
SCCRWA	CT0100081	CHESHIRE SEWAGE TREATMENT	2.09	Quinnipiac River
SCCRWA	CT0100404	NORTH HAVEN WPCF	2.84	Quinnipiac River
Meriden	CT0100315	MERIDEN WATER POLLUTION CONTROL FACILITY	8.57	Quinnipiac River
Southington	CT0100536	SOUTHINGTON SEWAGE TREATMENT PLANT	4.89	Quinnipiac River
Wallingford	CT0100617	WALLINGFORD SEWAGE TREATMENT PLANT	4.98	Quinnipiac River
Allnex	CT0000086	ALLNEX USA INC.	1.19	Quinnipiac River
United Aluminum*	CT0030201	UNITED ALUMINUM CORPORATION	0.28	Muddy River
Pharmacia & Upjohn*	CT0001341	PHARMACIA & UPJOHN COMPANY	0.13	Quinnipiac River
Nucor*	CT0026794	NUCOR STEEL CONNECTICUT, INC.	0.10	Quinnipiac River

3.1.6.7 Model Validation and Verification

A model validation process was used to verify that the model generally represents water availability throughout the basin by testing individually and collectively the ungaged flow estimates, the combination of flows, and the simulated water uses for 1988 to 2016. The purpose of the model is not to reproduce with high accuracy the flow on any given day in history. Rather, the purpose is to reproduce with confidence the frequency at which natural and managed flows have reached any given threshold, and by extension, how they might reach these thresholds under future use conditions. To this end, one important objective of model formulation was to reproduce hydrologic peaks and low flows on a monthly and daily basis, recession patterns on a monthly and daily basis, and average flows over months and years.

The primary parameters adjusted during model validation are reach gain/loss factors of tributary objects. These factors capture ungaged flow gains associated with increasing drainage area with distance downstream. Flow gains through a subbasin are initially assumed to be linearly proportional to drainage area, in line with common ungaged flow estimation techniques. However, there is significant uncertainty in this assumption and it is therefore appropriate to adjust these factors, within a small range, as part of the model calibration process. **Table 3-13** demonstrates the overall average error when comparing modeled to measured average streamflow at the three in-basin USGS streamflow locations. Note also that all upstream basin water use and operations are implicitly represented in these gaged data, thereby providing an ideal target to which the combination of estimated UIFs and historic water uses could be compared. **Figure 3-26** shows the modeled and average monthly timeseries of flows for the gage near Southington. The differences between modeled and measured flows may be attributed to various factors such as the averaging of water use on a monthly basis and potential error associated with metered/reported withdrawal amounts. Here, the differences are quite small, and the model trends on the conservative side since modeled low flows are slightly lower than measured low flows.

Table 3-13. Model Streamflow Gages and Average Error

Gage ID	Gage Name	Model Object	Modeled Avg (cfs)	Measured Avg (cfs)	% Difference
01196500	Quinnipiac River at Wallingford, CT.	Quinnipiac River	33.7	33.0	2.3%
01196561	Muddy River near East Wallingford, CT	Muddy River	236.8	239.8	-1.2%
01195490	Quinnipiac River at Southington, CT.	Quinnipiac River	15.1	14.6	3.3%

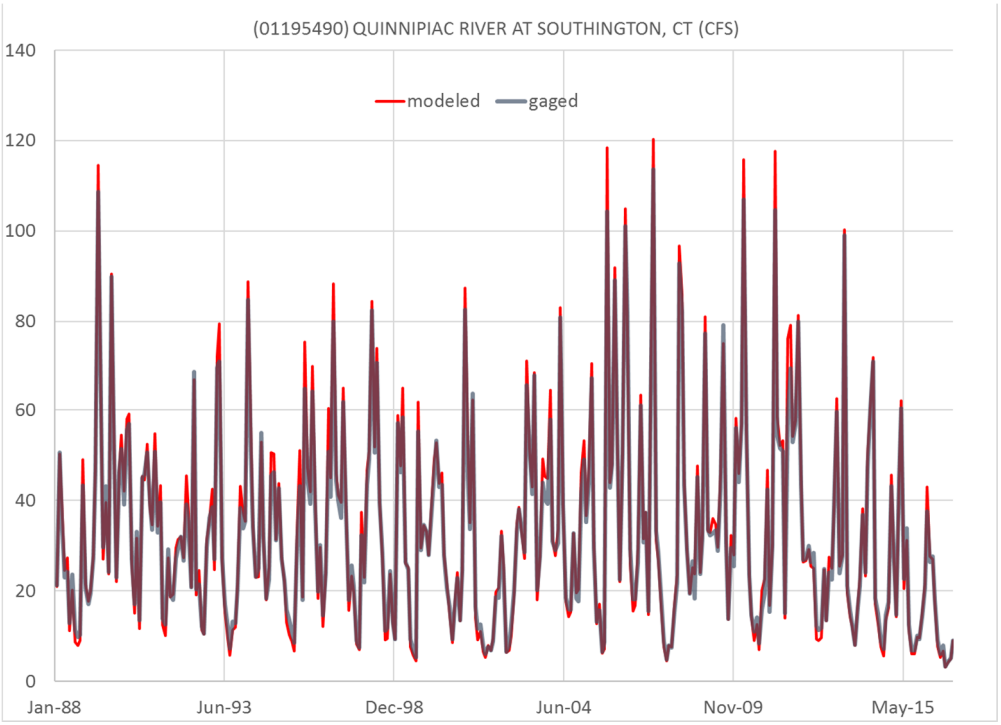


Figure 3-26. Modeled and Measured Monthly Average Streamflow

The lack of reach routing may limit the accuracy of the models at a daily timestep; however, a daily simulation can help provide important information during low-flow periods. **Figure 3-27** shows how the model performs against measured annual 7-day low flows for the same gage in Southington.

In addition to hydrologic adjustments, modifications were made to demand estimates and proportioning order and amounts of demand allocated between multiple sources for a single Water User object. For a user supplied by a single source, a need for a demand adjustment typically was flagged by repeated water shortages, which the subsequent adjustment could be justified as either due to uncertainty from demand estimation, or modification to the 1:1 well-to-river connection for a groundwater user. Source proportioning affects how a user fulfills their demands. For example, Meriden pulls from Bradley Hubbard Reservoir, Broad Brook Reservoir and wellfields on both the Quinnipiac River and Sodom Brook. While there are not available historic lake levels to calibrate to, the ability of the reservoirs to recover was noted when adjusting how much is pulled from each before sourcing from groundwater.

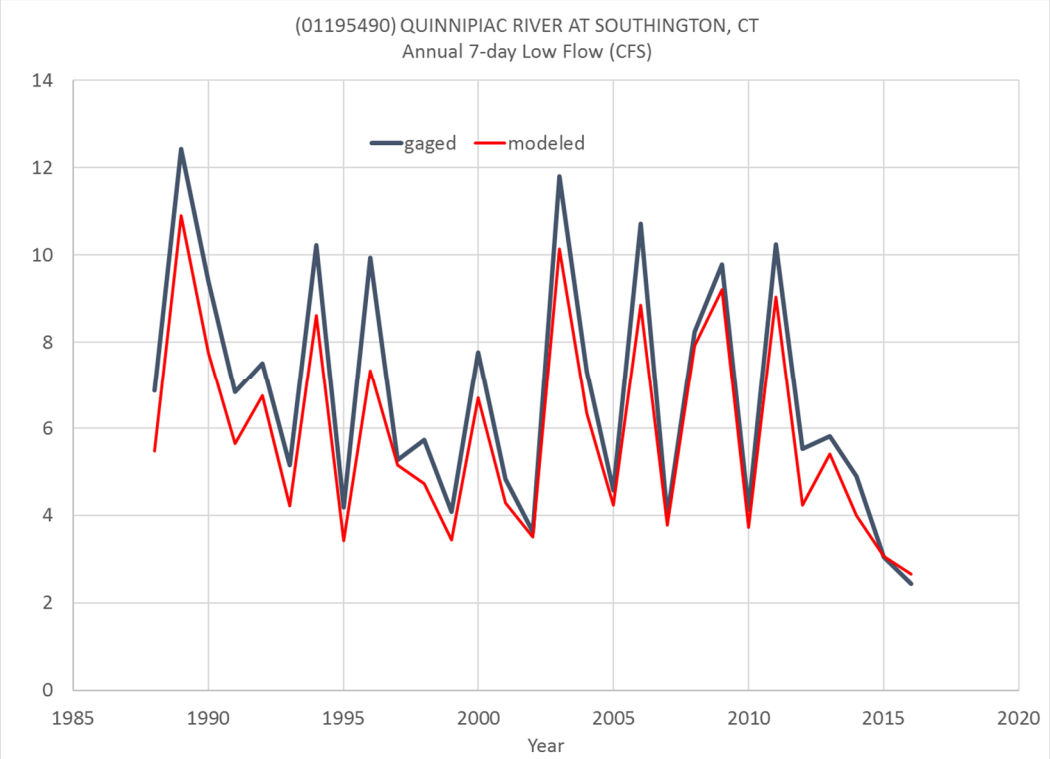


Figure 3-27. Low Flows. 7-day Annual Low Flows

3.1.6.8 Potential Model Uses

Water allocation models, such as the demonstration model developed for the Quinnipiac, can be used in many ways to support river basin planning and management. First and foremost, they enhance water manager's understanding of water availability. The models can be used to evaluate proposed or increased withdrawals and their impact on instream flows needs. Reservoir operational strategies can be tested, and multi-system withdrawals and releases can be comprehensively evaluated. The models can be used to evaluate drought triggers and test the potential effectiveness of drought management plans and conservation measures. Two simple,

hypothetical examples which demonstrate the potential use of the Quinnipiac model are presented below.

Evaluating Water Conservation Measures

The available historical timeseries of flows, as simulated by the model, provides a means to easily test the effectiveness of water conservation measures, and their impact in helping to prevent shortages and/or maintain flow levels that may be beneficial to aquatic life. In the hypothetical example scenario shown in **Figure 3-28**, outdoor water conservation measures (restrictions) for SCCRWA customers are conditioned upon available flow at the USGS gage located upstream from SCCRWA's wellfield on the Quinnipiac River. The red line in Figure 3-28 is average monthly demand, based on 2012-2016 SCCRWA reported values. When flow at the gage (not shown on the graph) drops below 10 cfs, certain restrictions in outdoor water use are implemented (in this example only – this is not an actual requirement), which result in a 10% decline in water demand and withdrawal. When flow at the gage drops below 5 cfs, more severe restrictions are implemented to affect a 25% decline in demand (again, for example purposes only – this does not reflect required or actual water use patterns). The demand resulting from these cutbacks are shown by the green line. Because these restrictions are tied to flow at the gage, when the flow increases above the trigger levels, the restrictions are removed, therefore green line fluctuates. If these types of restrictions were implemented, it is likely that the restrictions would be removed only if the higher flow were maintained for a number of days. While the results of this example show only minor, and seemingly insignificant increases in flow in the river adjacent to the wellfield due to the conservation measures, the example is meant to demonstrate the value of using such a model to quickly evaluate the effectiveness of a multitude of conservation and water management alternatives, and the balance between instream and out-of-stream water needs.

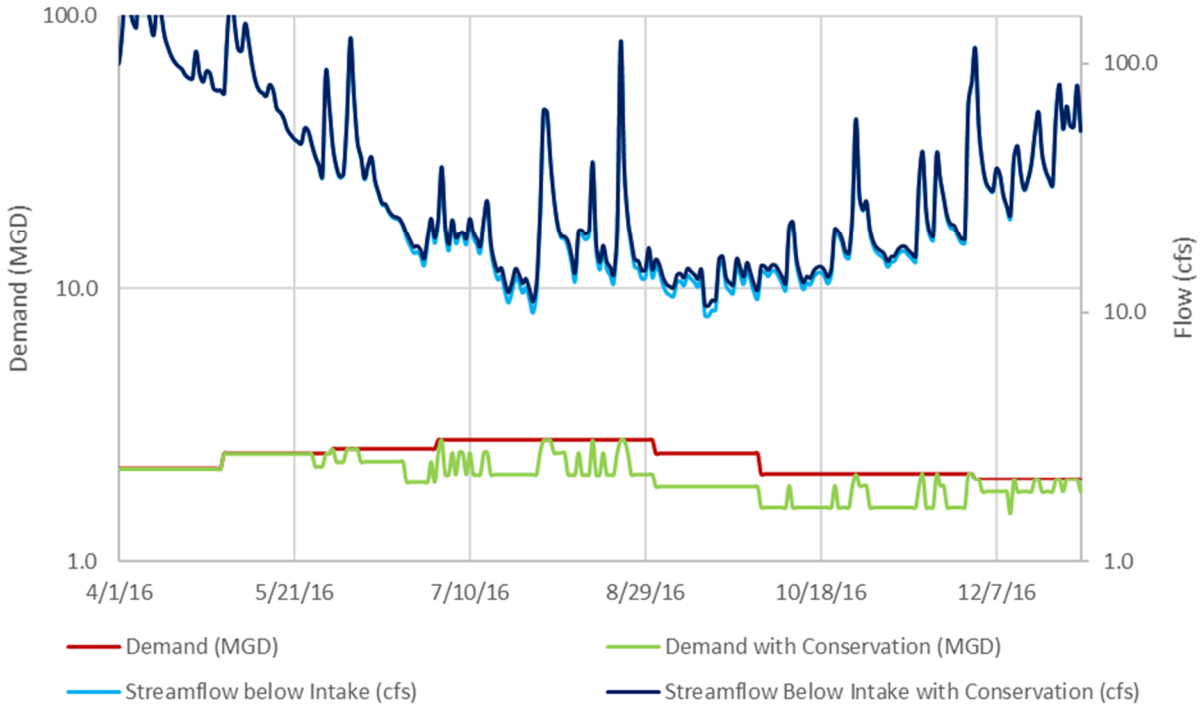


Figure 3-28. Water Conservation Example

Assessing the Impact of a Multi-Level Release Rule (MLRR)

Reservoir operations, and their effect on downstream flows can also be evaluated using the model. In this example, the pending Broad Brook Reservoir minimum required releases, per the MLRR, were compared to a "no release rule" scenario to gage the difference in storage and downstream flow. **Figure 3-29** shows the difference in Broad Brook Reservoir storage and downstream flows with and without the MLRR in place, using calendar year 2016 simulated inflows. Without the MLRR, and downstream flows beginning in mid-May drop considerably due to declining inflow and evaporation from the reservation, coupled with water supply demands. When the MLRR rule is followed, downstream flow reflects the minimum flows associated with each bioperiod, but at the expense of about 200 MG of reservoir storage by the end of the year. Note that the Town of Meriden has multiple sources of water, and the amount that was assumed to come from the Broad Brook Reservoir in this example may not accurately reflect their typical withdrawal. This simple example demonstrates how the model can be used to evaluate release requirements and their impacts. Both demand and inflows can be varied to evaluate a multitude of scenarios and outcomes.

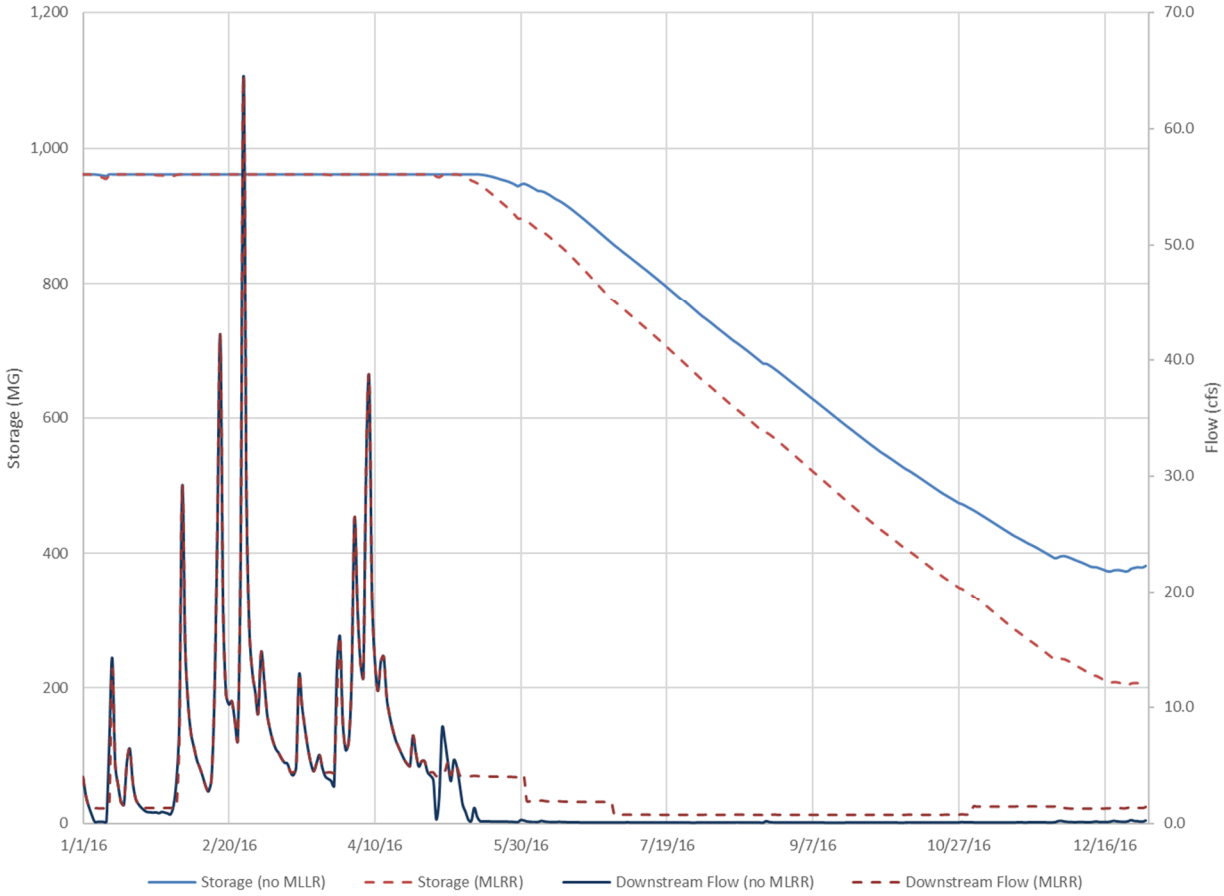


Figure 3-29. Reservoir Release Rule Example

3.2 Future Policy Assessment

Two white papers were prepared to identify and discuss future opportunities and challenges for water management in Connecticut. These papers are not intended to convey positions, priorities, values, or recommendations. Rather, they are factual documents reviewed by the four entities with purview over water: DEEP, DPH, OPM, and PURA, as well as the Water Planning Council and its supporting sub-committees and advisory groups.

The papers are introduced briefly below, and included in their entirety the two subsequent sections. Two additional white papers on current water and land management practices are discussed in Section 2.2.

The first white paper on future water policy is entitled "**Future Water Management Options**." It is included as Section 3.2.1 of this report. The state statute that calls for the development of a State Water Plan (Public Act 14-163) lists 17 issues that the plan should address, at a minimum. Many of these issues have been categorized by project stakeholders (during a facilitated workshop) as "Plan Objectives," and can be summarized by an overarching goal to "Balance the use of water to meet all needs." The other items in the list are categorized as strategic alternatives which, in various combinations, could help achieve this goal. The division of the statute's mandates into goals ("What problems are we solving and why?") and options ("How can we solve the problems?") has helped clarify the way in which the Plan will formulate recommendations for policies and future decision processes (see **Figure 3-30**). This paper outlines the broad strategies that may be used to address Connecticut's water needs – the "Options" for future water management. Both demand management and supply management options are discussed, and include, but are not necessarily limited to the lists in **Table 3-14**.

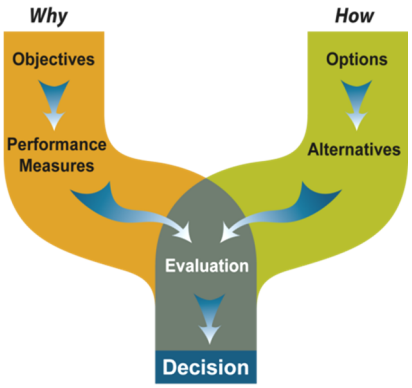


Figure 3-30. Separating the HOW and WHY of Water Planning

Water conservation has been a recurring theme emphasized throughout the first six months of the planning process, both by state agencies and by citizens of the state who have spoken at public forums. On the supply management side, use of Class B waters for non-potable use could be the option that provides the greatest flexibility in meeting all future demands, but the infrastructure is not necessarily in place to divide potable water from non-potable, either at the sources or at treatment facilities, and so this may ultimately become more viable in limited form by targeting Class B waters for specific facilities that could be retrofitted, rather than broadly through parallel distribution systems (to facilitate residential lawn watering, for example). Any use of Class B water to provide for a need that currently uses water treated to potable standards would effectively offset that potable demand. This paragraph does not attempt to prioritize the options, but rather, report out on options that have been widely discussed during the planning process, and which resulted in clear, consensus-based policy recommendations presented in Section 5.

Again, the complete white paper on Future Water Management Options is included as Section 3.2.1 of this report.

Table 3-14. Water Management Options to be Addressed by the Plan*

Demand Management Options	Supply Management Options
Water Conservation and Incentives	Use of Class B Water for Non-Potable Uses
Land Planning and Management	Water Reclamation / Reuse
Changes in Development Patterns	Interbasin Transfers
Green Building and LEED	Conjunctive Surface/Groundwater Use
	Collector Wells and Riverbank Filtration
	Aquifer Storage and Recovery
	Water Banking
	New Storage
	Expansions / Reoperation of Existing Storage
	Using Flood Control Reservoirs for Water Supply
	Flood Skimming
	Stormwater Capture
	Desalination

* The focus of the Plan is not necessarily limited to these options – complete lists of options will be developed through facilitated stakeholder workshops, as discussed in Section 4.

The second white paper on future water policy is entitled "**Future Water Management Challenges**." It is included as Section 3.2.2 of this report. Its purpose is to identify and describe some of the conditions within the State of Connecticut that will likely pose challenges to meeting the objectives of the State Water Plan with the available water management options and opportunities described in the white paper on Future Water Management Options (See above, and also Section 3.2.1). The white paper on Future Water Management Options (Section 3.2.1) is intended as a precursor to the white paper on Future Water Management Challenges **(**Section 3.2.2) – the two should be considered as companion documents.

The white paper on Future Water Management Challenges is an objective examination of the factors in Connecticut's natural environment and regulatory framework that will influence water management recommendations and decisions. Many of the challenges result from decisions that were made for the prevailing benefit of Connecticut's citizens and environment, but this does not exempt the decisions from challenging consequences that sometimes accompany the benefits.

Some of the challenges are faced by any state that undertakes a statewide planning process, some are shared by other New England states, and some are unique to Connecticut. Likewise, some challenges will be universally evident across the state because they originate in the state's regulatory framework and structure, and are likely to affect any future decision or recommendation, while others may affect only certain sectors of the water environment, or specific water uses. It is important to understand this difference, because different challenges must be met with appropriate breadth of responses when implementing the plan. As stated in other sections of this report, the Plan does not seek to prioritize any specific water use or type of use above or beneath any others – rather, it offers factual information and a framework of guiding principles with which to make legislative, regulatory, and project-specific decisions.

The paper on Future Water Management Challenges is not a critique of the future challenges, but an effort to broaden awareness of both the benefits and the potential hardships associated with current and past conditions. With this framework as its basis, the paper addresses the following future challenges to the implementation of water management opportunities (see **Table 3-15**).

Table 3-15. Future Water Management Challenges*

Overarching Challenges Inherent in the Connecticut Regulatory Framework (Section 1 of this Paper)	Challenges Unique to Certain Water Uses or Sectors (Section 2 of this Paper)
Connecticut's Established Home Rule	Water Allocation (registered diversions, permits, unreported uses, etc.)
Levels of Authority during Plan Implementation	Adoption of Instream Flow Requirements as an Ecological Water use (leaving some water in the rivers)
Connecticut's Prohibition of Class B waters for human consumption	Public Water Supply Issues (Coordination with WUCC process, Barriers to regionalizing small supplies, changes in future consumption)
Public Perception and Uncertainty	Watershed and Ground Water Protection Where Incentives are Lacking
Funding Constraints	Water System Vulnerabilities and Security Issues
Data Gaps	The Food-Energy-Water Nexus
Understanding Economic Impacts	Emerging Contaminants
	Aging Infrastructure
	Funding for Water Reclamation
	Constraints on Water and Sewer System Expansion

* The Challenges are not presented in any specific order of importance, and the paper explains that many of these challenges also have beneficial histories that will extend into the future for the benefit of Connecticut's citizens and environment.

These challenges are not necessarily issues that require formal policies or recommendations in the Plan, though the Plan does address many of them with recommendations. Rather, they are issues that will in one way or another affect the implementation of the water management options described **in** Section 3.2.1 (and above). An example is Connecticut's home rule standard of governance, whereby responsibilities for ensuring water supply for new developments reside with multiple municipal land use commissions and agencies. This may make it difficult to incentivize (monetarily or otherwise) or encourage regional solutions. The Plan will not recommend a change to this system, but rather, will acknowledge the challenges that it may pose to implementing new water strategies, and offer recommendations for how some of its perceived barriers could be overcome.

Again, the complete white paper on Future Water Management Challenges is included as Section 3.2.2 of this report.

3.2.1 Future Water Management Options

WP3-1. Demand Management Alternatives

WP3-1.1 Water Conservation

Water savings from water conservation can act to reduce future water demands, therefore avoiding or postponing the design and construction of new water supply and wastewater facilities. In addition, water conservation may serve several environmental and public health benefits, such as:

- Leaving additional water in streams and rivers,
- Reducing wastewater flow and having a positive water quality impact,
- Reducing pressure for additional sources of supply,
- Reducing energy consumption, and
- Increasing supply during dry conditions.

In addition, enhanced water conservation can work in tandem with drought management plans to buffer against drought.

"Municipal and Industrial" (M&I) is a term that encompasses public water system needs, as well as industrial water needs, including industries that are served by public water systems, or rely on their own sources of supply. M&I water conservation programs result in improved water use efficiency. M&I water savings occur through the modification of water-using fixtures (e.g., showers, landscapes, cooling towers) and behaviors (e.g., showering time, irrigation schedules, maintenance schedules). The effects of conservation on M&I water demand are the result of both passive and active water conservation efforts (see definitions below). These conservation efforts, though somewhat unpredictable in their rate of success (as they require changes in consumer behavior) can be effective means of reducing water supply needs with minimal direct cost to the community. However, it is possible that indirect costs may occur, such as increasing rates to offset declining revenue.

Water conservation can be grouped into the following categories or levels. (These are not national standards, but common categorizations):

- **Level 1 Water Conservation Savings:** This level is defined as water savings that result from the impacts of plumbing codes, ordinances, and standards that improve the efficiency of water use. These conservation savings are sometimes termed "passive" savings, as water utilities do not actively find and implement the programs that produce these savings. These savings occur as new construction and remodeled buildings become more water efficient over time. There are federal manufacturing standards for water using fixtures and appliances. Some states have codes that provide even more efficient standards. In addition, landscaping ordinances contribute to these passive savings.
- In contrast, water conservation savings resulting from utility sponsored water conservation programs are referred to as "active" savings. Note, emergency conservation programs and short-term drought response restrictions are not included among these long-term water conservation programs. Temporary drought restrictions include requests for

voluntary demand reductions, or mandatory water use restrictions during drought conditions. This type of demand modification usually involves drastic, temporary behavioral changes, such as not watering the lawn or washing the car. Droughts can also result in permanent water conservation benefits, such as retrofitting indoor plumbing devices with more efficient water saving devices by reducing or eliminating high water use landscaping.

- **Level 2 (Basic) M&I Conservation**: This level of conservation consists of programs for metering and leak detection, and can generally achieve about a 4 percent[14] water demand reduction in addition to the passive conservation reductions. Universal metering, as opposed to unmetered use, provides an awareness of use in addition to the transition from flat fees to volumetric charges. Leak detection and repair in the distribution system can reduce unnecessary water and revenue losses.
- **Level 3 (Moderate) M&I Conservation**: This level of conservation typically includes programs for metering and leak detection, as well as education, rebates for water-efficient toilets and washing machines, and a rate structure that promotes effective water use. This level of conservation can generally achieve about 5 percent water demand reduction in the short to mid-term (10 years). The estimated percent reduction is inclusive of Level 2 savings.
- **Level 4 (Aggressive) M&I Conservation**: This level of conservation typically includes programs above and beyond moderate conservation, such as: steep pricing rate and surcharges, rebate for landscape changes, residential and commercial audits, turf replacement and restriction, rebates for irrigation sensors and controllers, sub-metering of master-meter properties, and fixture retrofit upon sale of properties. This level of conservation can generally achieve about a 10 percent water demand reduction in the short to mid-term (10 years). All efforts described in the previous levels are assumed to be in place, thus the percent reduction is inclusive of those savings.
- **Level 5 M&I Conservation:** Program savings are influenced by the level of participation and compliance with a given program. The prior levels of conservation effort (2 through 4) assume a reasonable level of program participation. Level 5 assumes total participation by all customers and is intended to represent a maximum level of effort in water use efficiency. Such a level of conservation is estimated to achieve about 15 percent water demand reduction in the short to mid-term (10 years).

It is also important to note that the *realistic* level of future water demand varies by location given the water conservation programs currently implemented or budgeted. Local attitudes and the "conservation ethic" of the community can have a significant impact on the success of water conservation programs. It is also important to note that there is a downside to water conservation from the standpoint of revenue generation, depending upon the design of the water rate structure. Leak detection can also contribute to water savings for public water systems.

[14] This estimate is based on CDM Smith's experience with water conservation programs across the United States.

Evaluating New Supply from M&I Water Conservation

The ability to develop new supplies from water conservation or to carry over conserved water for future use is dependent on the local utility, since this will depend on the system storage, diversions, firm yield of water supplies, total water consumption, etc. The benefits of water conservation include:

- Implementation costs that can be significantly lower than new water supply development or other alternatives.
- No permitting requirements to implement water conservation.
- Implementation is within the control of the local water provider and does not require approval of other entities. Although rates that account for conservation must be approved by PURA or a local board.
- No new diversions are required.
- Existing water supplies can be stretched to supply the demands of new growth.
- Lesser environmental impacts than new water supply development.
- Can reduce water and wastewater treatment, distribution, collection, capital, and operations and maintenance costs.

Although the potential for capital cost avoidance is significant when conserved water becomes "new" water, the savings need to be weighed against the continuing operations and maintenance costs that occur, even as revenue decreases due to customers' conservation efforts. The timing of this issue may be a key consideration, as the decrease in revenue occurs prior to the re-purposing of conserved water as a new water supply; therefore, well ahead of any opportunity to restore revenue from the distribution of the "new" supply.

Status of Water Conservation in Connecticut

Domestic and Potable Water Use

The State of Connecticut encourages and requires water conservation through several resources. The DPH maintains water conservation fact sheets for owners of private wells, including customers of water utilities. These conservation tips are often passed on to residents and business owners through local health departments, municipal departments, municipal commissions, and water utility bill stuffers.

All water utilities serving greater than 1,000 people are required to maintain a Water Conservation Plan per the Individual Water Supply Plan regulations. The Water Conservation Plan is designed to meet the long-range conservation goals of the water utility. Water conservation plans focus on supply management and demand management programs. Supply management is focused on reducing the loss of water through metering, water accounting, leak detection, leak repair, etc. Supply management can also include promotion of the recycling of water, especially in large industrial settings. Demand management actions are designed to encourage the reduction of the peak and average daily demands caused by customer water use habits. This is accomplished through residential retrofits, raising public awareness of water consumption, strategic rate-setting, etc.

Water utilities that maintain water diversion permits, including those that file Water Conservation Plans and those that do not, are typically required by permit condition to conduct leak detection surveys every three to five years. The results of the leak detection surveys are required to be submitted to DEEP in the annual reports that are prepared pursuant to diversion permit conditions.

Since the materialization of the Water Supply Plan regulations in 1986 and the National Energy Policy Act of 1992, coupled with the diversion permit conditions imposed on many water utilities -- major water utilities in Connecticut have made significant progress in reducing non-revenue water (calculated by comparing water produced with water consumed), while *also* observing a reduction in the per capita water demand (gallons per day per person) calculated from metered water consumption. Many water utilities are experiencing non-revenue figures well below the off-cited industry standard (15%) while many customers are enjoying per-capita demands on the order of 30 gpd/person to 60 gpd/person[15]. These figures are well below the design standard of 75 gpd/person that is required for designing new water systems. A national study of single-family residential water use conducted in 1999 by the Water Research Foundation showed an average indoor residential water use of about 69 gallons per capita per day. A repeat of this study conducted in 2015 showed this number to have dropped to about 59 gallons per capita per day. This is about a 15 percent decrease over 15 years due primarily to improved water efficiency for toilets and clothes washers.

In the coming years, the challenge will be to further conserve water using these top-down approaches. Water utilities are challenged to suggest new ideas or techniques in their Water Conservation Plans, while most consumers are accustomed to seeing the same water conservation bill stuffers year after year. New high-level approaches will be needed to encourage conservation, including incentives for the water utilities. At the same time, water utilities need methods for paying operating expenses, infrastructure repairs and upgrades while experiencing a declining revenue stream. In particular, water utilities that are not permitted or otherwise able to include a water conservation surcharge (to compensate for revenue reductions due to conservation) will experience this challenge.

Other Water Users

The State of Connecticut has fewer tools available for encouraging water conservation among industrial, agricultural, and other non-potable water users. The chief mechanism is through the water diversion program. Permitted withdrawals (those that exceed 50,000 gpd and that were not registered in 1983 pursuant to the Water Diversion Policy Act) are required to abide by a series of special conditions that result in metering, reporting, and water conservation. Many permits require the completion of water conservation plans and the annual reporting on progress made toward water conservation. For example:

- Prides Corner Farms (a large grower of container plants, trees, green roof materials, and other products) must annually report on water conservation practices for its four nurseries in Lebanon.

[15] Refer to the Water Utility Coordinating Committee (WUCC) process and reports for figures that have been compiled from Water Supply Plans.

- Various sand and gravel producers must recycle wash water, and diversion permits will stipulate the volumes of recycled water and makeup water that can be withdrawn each day.

Aside from the water diversion program, there are not many top-down tools to encourage water conservation. The registered diversions are not required to implement water conservation techniques (except for the public water systems, which must conserve as described above). The Natural Resources Conservation Service (NRCS) typically works with the agricultural and nursery water users in Connecticut to identify a variety of soil and water conservation techniques, but then again these are often guidelines.

Individual Water User Level Conservation

Domestic and Potable Water Use

Modern appliances, water fixtures, and practices have made water conservation an achievable task at the water user level. There are a number of ways that individuals can significantly reduce their water use.

Replacing old faucets, showerheads, and toilets can significantly reduce water consumption. A modern showerhead with a flow rate of 2.5 gpm can use half the water of an older unit. Often, due to better technology, the perceivable difference in water output is minimal, despite the drastically reduced flow rate. Modern appliances, such as dishwashers and washing machines are also able to do more with less water. For instance, home practices like stormwater capture for reuse (i.e. rain barrels), drip irrigation, reducing at-home carwashes, and watering lawns outside the heat of the day can also conserve significant amounts of water.

At-home water conservation efforts can be inexpensive, and can pay for themselves in water savings. For example, based on a local utilities billing rate, changing a 5 gpm shower head to a 2.5 gpm low flow showerhead can save $50 dollars per year in water usage per person, based on one daily 10-minute shower.

Other Water Users

Other users of water typically conserve water as a cost-savings measure. For example, agricultural and nursery water users can install drip irrigation systems to reduce water usage; therefore, saving money to purchase and/or pump water. Businesses and industries can save water by retrofitting cooling towers, restrooms, and irrigation systems. Like many options, characteristics of the water user including size, age of existing systems, operational needs and funding availability will determine the feasibility and effectiveness of these measures.

Incentives for Water Conservation

Many states have rebate programs and incentives for the purchase of environmentally friendly household appliances and products. Currently, states like California offer rebates on the purchase of new toilets, washing machines, rain barrels, pool covers (which reduce evaporation), and other water saving devices and appliances. At the moment, Connecticut does not have a rebate program. Some utilities offer cost-sharing or incentives based on volumetric reductions in water use for commercial and industrial customers. Due to the state budget considerations and the relative abundance of water, it is unlikely that the state would pursue these options immediately. However, if the financial investment was made, the benefits to the consumer and to water

conservation efforts would be significant. Reviewing and updating building codes may also be an important consideration in guaranteeing that the most efficient water saving devices are required.

On a broader level, there are incentives for conserving water in the agricultural industry available through the NRCS. For example, in the Little River and Broad Brook watersheds[16], the National Water Quality Initiative program offers "technical and financial assistance to farmers and forest landowners interested in improving water quality and aquatic habitats in priority watersheds with impaired streams. Qualified producers may apply for financial assistance to install conservation practices in the designated watersheds to address documented phosphorus, bacteria, and sediment impairments which may be caused by soil erosion, exposed soil, and lack of riparian buffers and filter strips."

WP3-1.2. Land Planning and Management

Land use planning and management affect many resource management strategies for a State Water Plan. More efficient and effective land use can be linked to several resource management programs including watershed management, water use efficiency, groundwater quality, flood management, parks and recreation, climate change adaptive management, and agricultural lands stewardship. In addition, planning for more compact and sustainable communities, both urban and rural, can assist in reducing impact on water resources. Important considerations of water issues and land use planning include, not only the effects of the physical environment, but also the economic and social impacts of land use planning and development.

Stronger collaboration between land use planners and water managers can promote more efficient and effective land-use patterns and integrated regional water management practices that can produce safer and more resilient communities. Integrating land use and water management consists of planning for the housing and economic development needs of a growing population, while providing for the efficient use of water, water quality, energy, and other resources. The way in which Connecticut uses land — the type of land use, transportation, and level of use — has a direct relationship to water supply and quality, flood management, hazard mitigation, and other water issues. Likewise, the better integrated water resources are, the more efficient local communities can be in producing land use planning benefits and opportunities. For example, compact development patterns in existing urban areas could limit the amount of development in floodplains, leading to improved flood management and safety and a more efficient infrastructure.

Land use planners consider water throughout the local land use planning process, and water is a critical element in adopting efficient land use planning policies. The availability of water supplies and water resource features, such as streams, wetlands, and groundwater recharge areas, policies and regulations about water quality, drainage, and flooding are all considered for a community's land use vision. Planners should also consider the benefits of integrating water related features for flood management, water supply and quality, recreation, as well as climate change adaptive management.

[16] Refer to www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/equip/?cid=nrcs142p2_011038

Land use planning and management share strategies and benefits with watershed planning and management, agricultural lands stewardship, water use efficiency, water quality management, and climate change planning, to name a few. The themes of flood risk and surface water management can meet sustainability issues in land use planning. These strategies benefit from participation by all levels of government relying on local knowledge and management capacity. Commonly, with many other cross-cutting themes in local government, the quality of outcomes depends on joining services and various stakeholders effectively. These listed management strategies and others tie in with the following sustainability issues:

- Climate change adaptation includes preparing for flooding, and
- Sustaining existing biodiversity and its potential enhancement -comes by managing waterways.
- Community engagement increases public awareness of the issue.
- Development and provision of green infrastructure increases sustainability.

WP3-1.3. Changes in Development Patterns in Connecticut

Managing development in harmony with existing and proposed public water infrastructure can provide numerous economic and environmental benefits. Development that is focused around and within water distribution systems reduces the need for additional pipelines and infrastructure. As opposed to extending pipelines out long distances to developments, local use saves energy required to pump water further and reduces unaccounted water due to leakage from long mains.

Developing so that one large water supply utility can serve a large group of customers can pay dividends not only economically, but also by improving service reliability and safety. Small systems cost more to maintain per unit water produced due to the economics of scale and the reduced spatial component of critical infrastructure like towers and treatment stations. Large systems are much more likely to feature redundancy in supply sources, storage, and treatment; and also are required to submit water supply plans that can help build capacity. Their infrastructure is more likely to be staffed and accessible during emergency situations, and more likely to be prioritized when the need for repairs is present.

If focusing water service within the footprint of existing distribution systems can be prioritized, there may be more opportunities for developing and redeveloping land in such a way that per-capita water use can be minimized. For example, smaller lots with xeriscaping tend to use less water than larger lots with turf grass irrigation needs. Plus, newer housing units are fitted with the low-flow fixtures that are available to contractors. Cluster development may accomplish some of the same goals, but not if such development is occurring far from distribution systems. Stream-belt protection can also play an important role in preserving water quality. 34 municipalities in the state have stream-belt zoning regulations.

WP3-1.4. Green Building and LEED in Connecticut

LEED, or Leadership in Energy and Environmental Design, is a certification issued by the United States Green Building Council. This program uses a process where points are awarded to buildings based on the implementation of various sustainability practices. Depending on the

number of points earned, one of four LEED ratings are achieved: Certified, Silver, Gold, or Platinum.

LEED certifications can apply to building design and construction, interior design and construction, building operations and maintenance, and to larger scale neighborhood development. The LEED scorecard bases its rating on factors such as indoor and outdoor water use reduction, renewable energy usage, high efficiency fixtures and lighting, environmentally friendly cleaning and waste management practices, and numerous other factors.

Buildings built to LEED standards will tend to reduce consumption of natural resources, and use materials which are more environmentally friendly. Some buildings with LEED certification can even achieve a carbon neutral or carbon negative state, meaning that the net carbon footprint of the building is offset by renewable resource generation and energy efficient practices within or around the building.

Effective July 1, 2007, Connecticut passed Public Act 07-242, An Act Concerning Electricity and Energy Efficiency. PA 07-242 requires the state building inspector and the Codes and Standards Committee to amend the State Building Code to require buildings costing $5 million or more, or renovations costing $2 million or more, to meet the LEED silver standard or its equivalent. These requirements apply to both private and public sector projects, other than residential buildings with up to four units. These types of projects are required to exceed the current building code energy efficiency standards by at least 20%.

The State of Connecticut does not provide financial assistance for building owners or developers to meet or exceed LEED requirements. However, there are some incentives for building owners and developers. For example, the state exempts various energy efficiency goods, such as furnaces that meet federal Energy Star standards and insulation, from the sales tax. Municipalities are also required to exempt several types of renewable energy systems from the property tax. Connecticut also has a net metering law where buildings that use renewable resources systems to generate electricity sell the power back to the electric companies.

The Connecticut Green Building Council (CTGBC) is Connecticut's local chapter of the US Green Building Council (USGBC). Throughout the year, CTGBC holds a series of workshops on green building topics, networking opportunities, membership meetings, educational forums, seminars on green buildings and periodic Connecticut-based LEED training in connection with the US Green Building Council.

WP3-2. Supply Management Alternatives

WP3-2.1. Use of Class B Water for Non-Potable Sources

Connecticut uses only Class A or Class AA surface waters for drinking water. Section 22a-417 of the Connecticut General Statutes prohibits discharge of sewage to water supply impoundments. Therefore, Class B surface waters, which are designated in accordance with the Connecticut Water Quality Standards, in part, receive and assimilate treated wastewater are not utilized for public drinking water supply. This topic is discussed further in Section 3.2.2, as the prohibition itself creates a set of challenges in the state, despite its numerous benefits.

According to various water supply plans, residential use water accounts for about 2/3 to 3/4 of the water consumed by customers of water utilities. The remaining water is used for commercial, industrial and public service uses. Some of the water used by industries is not intended for drinking, depending on the nature of the industrial customers. For example, many large water utilities provide water to power generation facilities on a daily basis or in reserve, and sometimes at levels of 0.3 mgd to 0.5 mgd. This is sometimes water that could be sourced from Class B rivers. Major Class B sources in the state, like the Connecticut River and Housatonic River, could potentially provide large quantities of non-potable water depending on the proximity to such sources; the adequacy, quality and availability of the supplies; and permitting considerations. Connecticut has many examples of golf courses, nurseries, and small agricultural facilities that utilize the adjacent public water system (typically Class A water) for supply (either backup, supplemental, or the primary supply).

However, using Class B waters for specific customers like power plants and golf courses is relatively easy compared to the more difficult scenario of using Class B waters for the non-potable needs of customers that otherwise have mostly potable needs. For example, a large commercial establishment may have mainly potable water needs for drinking and sanitation, but landscaping needs that could be served by Class B waters. Connecticut, like all states, has a strict public health code that has provisions in place to monitor for, and prevent, cross connections between potable and non-potable systems. Plus, the cost barriers are significant to installing separate potable and non-potable water systems on a parcel, neighborhood, or system scale. Consideration would need to be given to the impacts on ratepayers and users of systems where redundant piping would be required, and the incremental effects on growth and economic development.

There are situations where there has been linkage of non-potable sources to non-potable uses (e.g., some of the power generation facilities that have been proposed or constructed in the last 15 years), but more progress is desired by many people. The following two examples highlight situations where potable water will be used for non-potable uses that could have potentially been supplied by Class B waters:

- One of the state's most recent gas-fired power plants was developed in Middletown and uses water from collector wells that draw from the Class B Connecticut River. The Towantic Energy facility, which is under construction, in Oxford needs a backup source of water for cooling. The only viable source appears to be the local public water system. Not only is water needed for cooling, but additional water is needed for air emissions during oil-fired operations. Many people believe that non-potable waters should have been a priority consideration in siting the facility.
- A large nursery is expanding in Connecticut and has purchased a new site in a town with an extensive public water system. To avoid the expenses and permitting uncertainties associated with developing new ponds and/or groundwater supplies, the nursery plans to use the potable water system for irrigating product. Although not a concern for this example, other nurseries that grow food products may be constrained by requirements to utilize high quality waters for irrigation.

An additional point regarding power generation facilities is that some facilities have very specific water quality needs that may not be met with Class B waters. In some cases, this can be addressed by treatment processes employed by (and located at) the power generation facility. But in other cases, the generation facility may be better served by using potable water for cooling and other processes.

WP3-2.2. Municipal and Industrial Reuse

M&I reuse (sometimes referred to as "water reclamation") involves a second or consecutive uses of consumable water supplies that have first been used to meet municipal or industrial needs but not fully consumed. Consumable effluent is defined as effluent that a public water system can reuse. Nationwide, this can be both potable and non-potable, but in Connecticut the prohibition of Class B water for potable use would limit reuse water to non-potable uses.

Non-potable reuse involves the capture and use of reusable return flows for duel supply (flushing toilets), the irrigation of landscapes, or for industrial uses such as cooling or process water. Since return flows from landscape irrigation are hard to capture in one location, non-potable reuse to date has involved the reuse of consumable effluent discharged from wastewater treatment facilities. The effluent undergoes additional treatment to meet non-potable reuse standards. This treatment usually involves filtration and additional disinfection.

Potential benefits of non-potable reuse include:

- Improves M&I reliability.
- Maximizes successive uses of water.
- Maximizes beneficial use of water.
- May not require new diversion structures.
- Lesser environmental impacts than a new water supply project.
- Does not use higher quality drinking water for irrigation.
- Does not use high quality water for snowmaking.

Potential issues and concerns include:

- Can be very expensive.
- Must have consumable effluent (a source of effluent that isn't needed elsewhere) to reuse or identified return flows.
- Wastewater treatment plant needs to be near irrigation demands.
- Must have storage to regulate year round effluent flows and meet demands during irrigation season.
- Public acceptance of the reuse of effluent for landscape irrigation must be achieved.
- Pre-treatment requirements to address water quality regarding pathogens and other constituents.

WP3-2.2.1 Reclaimed Water for Non-Potable Uses in Connecticut

Two water reclamation facilities have been established in Connecticut. The Mashantucket Pequot Tribal Nation uses reclaimed water (treated sanitary wastewater) as the predominant supply for its Lake of Isles Gold Course irrigation. This supply is augmented by potable water, but as wastewater supplies have increased, potable water use has lessened.

The University of Connecticut opened its reclaimed water facility in 2013. Most of the output from the $25 million facility is used to provide heating and cooling water at the University's Co-Gen power facility. The facility has the ability to process up to 0.5 mgd on peak days, which is enough to supply the entire water needs of the plant. The facility can also be potentially used for gray water in new buildings and field irrigation.

Despite these two successes, there were significant barriers that Mashantucket Pequot Tribal Nation and UConn could traverse by virtue of their unique nature as water and wastewater utilities. For example, Mashantucket Pequot Tribal Nation is sovereign, although the Lake is Isles Golf Course is not. The tribal utility authority could access funding reserves to pay for the microfiltration facility, and had readily available land for the facility. The State of Connecticut had a keen interest in funding significant water conservation measures at UConn, and the state obviously had land available for the facility. Both Mashantucket Pequot Tribal Nation and UConn also had easy access to sanitary wastewater effluent.

Even with UConn's success in using reclaimed water for heating and cooling, some other intended uses (for example, landscaping needs) have not yet materialized due to logistical and permitting barriers.

When considering how the Mashantucket Pequot Tribal Nation and UConn proceeded with reclaimed water facilities, it is extremely difficult to find other easy examples in Connecticut. Following in the same model, attention could turn next to the largest of the state's universities (such as the Connecticut State University system) as well as the larger industrial and commercial facilities in the state that have sufficient control of their land (such as Pfizer, ESPN, etc.) and easy access to treated effluent.

WP3-2.2.2 Household Graywater Use in Connecticut

A broad definition of gray water is wastewater drained through sinks, lavatories baths, showers and washing machines. Although it is wastewater, gray water is largely devoid of any human waste. Gray water can be used to flush toilets, water grass, and in many other non-potable applications.

Cost considerations in addition to the gray water collection system include the additional plumbing needed to allow appliances to operate using the separate greywater system, and a treatment system to remove pathogens from gray water before re-use. Although gray water does not contain human waste, water from dish, hand and clothes washing can contain sufficient pathogens as to be a biological concern. Gray water systems can use multistage systems utilizing media filtration and UV sterilization to render water fit for reuse.

If pursued extensively in Connecticut, gray water systems (just like capture and use of stormwater at the end of this paper) would not be a comprehensive solution for multiple properties or neighborhoods. It would likely be used case-by-case to reduce the use of potable water supply through individual service connections to individual properties. Cross-connection issues would be important to address to ensure that drinking water systems remain safe. Several examples of LEED-certified buildings that use graywater and/or stormwater can be identified. The potable water needs of these buildings are therefore limited to drinking, cooking, etc.

WP3-2.3. Coordination Regarding Interbasin Transfers

Interbasin transfers remain a contentious issue within the state of Connecticut. By definition, an interbasin transfer moves water from one subregional drainage basin to another. The subregional drainage basins "of record" are those delineated in the *Atlas of Public Water Supply Sources and Drainage Basins* (1982, CT DEEP). The reasons for performing such transfer are numerous, but fundamentally involve extending water from a place of surplus to a place needing supply.

Many of our longest interbasin transfers are quite old, and date back to the time that our industrial cities (Hartford, Waterbury, Bridgeport, New Britain) were siting and developing surface water supplies that were quite distant from the city centers. In recent years, interbasin transfers have typically involved movement of treated water through pipelines from systems that have excess water to systems that need additional water.

Both the DEEP and DPH allow interbasin transfers. Transfers of 50,000 gallons or more per day require diversion permits. In some cases, a higher level of environmental review has been required[17] due to the triggering of the Connecticut Environmental Policy Act due to state-funded or state-sponsored actions. The environmental, economic, and societal effects of interbasin transfers are varied but generally positive, or they would not be authorized or desired. Opponents argue that transfers alter ecological conditions by redistributing flows from one river basin to another. From an economic and societal standpoint, opponents argue over priority of water distribution in the event that a large scale water shortage afflicts the source basin, and/or the basins it supplies.

Although the opposition to interbasin transfer is well documented, proponents note major benefits to the practice. Some view the transfer as a way to encourage development and economic growth in an under producing basin by using surplus water from another. Others note that interbasin transfers help strengthen the water utilities' ability to provide water under adverse conditions, as multiple sources of supply increase redundancy and reliability of the system. Proponents further note the potential benefit of moving water from water rich areas to more environmentally stressed areas to reduce impacts from developing additional supplies in areas where there may be demands.

[17] University of Connecticut Environmental Impact Evaluation for New Water Supply (2011-2013) and Town of Middlebury Environmental Impact Evaluation for water main extension and interconnection (2006-2007).

Ideally, the state may one day be able to plan or "pre-program" potential interbasin transfers in order to more effectively address water needs and imbalances. Connecticut's development patterns of suburbanization superimposed on traditional New England villages and old industrial cities means that water demand will not always be balanced with supply availability. Thus, while some sources may be stressed, others will be underutilized. Planning interbasin transfers before problems arise enables the state to balance the interests of various parties and acclimate to changing demands in a timely manner when the need finally arises. The WUCC process can also help in this regard.

WP3-2.4. Conjunctive Use of Surface Water and Groundwater

Conjunctive management or conjunctive use refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Surface water and groundwater resources typically differ significantly in their availability, quality, management needs, and development and use costs. Managing both resources together, rather than in isolation, allows water managers to use the advantages of both resources for maximum benefit.

Conjunctive management thus involves the efficient use of both resources through the planned and managed operation of an aquifer and a surface water storage system combined through a coordinated conveyance infrastructure. In its simplest form, conjunctive use involves using surface water when surface supplies are ample, such as during average to above average runoff conditions. When surface water supplies are in short supply, such as during below average runoff conditions, groundwater supplies would be used to a large degree to meet demands.

The necessity and benefit of conjunctive water management are apparent when surface water and groundwater are hydraulically connected. Well-planned conjunctive management that prevents groundwater depletion and helps maintain baseflow to streams and support for ecosystem services not only increases the reliability and the overall amount of water supply in a region, but also provides other benefits such as flood management, environmental water use, and water quality improvement. In Connecticut maintaining baseflow can be accomplished by preventing groundwater depletions along smaller streams. Except for very short reaches, almost all streams are gaining reaches.

Physical and legal limitations affect the reliability and sustainably of groundwater as a source of supply. Physical availability measures the amount of water an aquifer can produce, both in the short- and long-term, and primarily affects the sustainability of the resource. Legal availability relates to the amount of water that can be extracted from an aquifer under the water rights administration system that exists in a particular area, and can affect the reliability of the supply.

In the context of water supply, aquifers can be categorized as being renewable or non-renewable. Aquifers that are located in the floodplain adjacent to rivers typically are composed of stratified glacial deposits and have a hydrologic interaction with those rivers; they dynamically get water from or discharge water to the rivers throughout their reaches. Aquifers of this type are referred to as tributary or valley-fill aquifers. They usually are unconfined aquifers that are relatively shallow. Valley-fill aquifers are considered to be a renewable source of water since they are hydrologically linked to renewable supplies such as precipitation and infiltration of surface water.

The other category of aquifer, non-renewable, is one that is not replenished from renewable sources such as rivers or infiltration of rainfall. Non-renewable aquifers generally are located deep below the land surface, in consolidated bedrock deposits, and would be classified as confined aquifers. Although non-renewable aquifers are common in many parts of the country, Connecticut has few deep, extensive confined aquifers. The fractured bedrock aquifers are locally recharged, although at a slower rate than the valley-fill aquifers.

Conjunctive use of surface water and groundwater can maximize the benefits and reliability of both surface water and groundwater sources of supply.

WP3-2.4.1 Conjunctive Use of Groundwater and Surface Water in Connecticut

Conjunctive use relies on the combined strengths of nearby surface and groundwater sources (typically in the same drainage basin) in order to balance aberrations in capacities based on seasonal and other factors. Small and moderately-sized surface water systems, while able to be filled very rapidly under certain conditions, are also susceptible to high rates of evaporation and severe dry spells. This is not typically the case for the largest surface water reservoirs in Connecticut. Groundwater sources can be slower to recover than surface water, in some cases, however their output is generally steadier, with less variation over time, similar to the largest of the surface water reservoirs.

By reducing reliance on a single type of source, a utility's resilience to adverse conditions increases dramatically. For example, if an intense rain event occurred in a drought stricken area, producing high runoff, a surface water body or flood skimming operation may be able to take advantage of the high rates of runoff. Consequently, in a situation where high ET and low rainfall caused reservoir supplies to suffer, groundwater may be able to augment supply during that time.

Many water utilities in Connecticut already utilize groundwater supplies and surface water supplies. Examples include Manchester, Middletown, Wallingford, Meriden, Aquarion Water Company, RWA, and The Connecticut Water Company.

However, many water utilities in Connecticut formerly operated small reservoir systems but made them inactive due to the requirements for filtration under the SDWA, opting to develop wellfields. These systems now utilize wells for most (or all) of their daily supply, although the old reservoirs are still located nearby and have been relegated to other beneficial uses such as passive recreation. It may be useful to evaluate whether some of these systems could identify methods of restoring reservoirs to public water supply, thereby reducing the stress on their wellfields and the aquifers that are tapped. Returning pre-SDWA reservoirs to active use in part to reduce stress on wellfields would come with substantial costs for designing, building, and operating new filtration plants. There could also be significant and challenging environmental and social conflicts to address when reactivating these sources, such as those experienced by RWA when the Lake Whitney Reservoir was reactivated.

Likewise, systems that operate only reservoir systems may be situated in places that are underlain by productive aquifers. These systems may wish to explore the possibility of using groundwater if there is a need to reduce stress placed on surface water systems and the rivers that flow through them.

It should be noted that conjunctive use issues are not limited to public water systems. There are many water users in Connecticut that use both surface water and groundwater for flexibility and reliability, including many of the sand/gravel production and washing facilities, many golf courses, and several nurseries.

WP3-2.5. Collector Wells and Riverbank Filtration for Potable Uses in Connecticut

Riverbank filtration involves the process of installing pumping wells near a river channel, in order to induce a hydraulic gradient and filter water through the riverbank. Not only does the induced infiltration greatly increase the amount of water the well can pump, the induced infiltration also causes the water to flow through the substrate and banks where a variety of physical and chemical purification processes occur. Riverbank filtration uses large vertical wells which draw water some horizontal distance from the stream channel. Often, the influence of these wells draws from both "true" groundwater sources by intercepting groundwater that would have discharged to the river, as well as river water. The state has several examples of riverbank filtration, although the aquifer thicknesses and pathways traversed (from riverbed to wells) are more substantial in Connecticut than they are in many other settings in the United States. Most high capacity wells in Connecticut are located near streams and benefit from the induced infiltration and riverbank filtration.

A related practice to bank filtration is achieved with collector wells, which are large, vertical caissons with horizontal arms that draw water from beneath a river. They are composed of a central shaft, which is installed some distance below the surface. Several appendages are projected out horizontally underneath the stream channel. Since collector wells are situated directly below the stream channel, they are more likely to draw from predominately surface-sourced water, as opposed to tapping into the aquifer. Several collector wells are operating in Connecticut, including the most recently-constructed (the River Road Collector Wells in Middletown, currently used by a gas-fired power plant). Other inactive or active collector wells are located in Naugatuck (Naugatuck River), Wallingford (Quinnipiac River), and Rocky Hill (Connecticut River).

Although wells located close to rivers are common in Connecticut, river water quality must be carefully controlled to minimize pollutant inflows, as bank filtration has a limited capacity to remove many contaminants, like herbicides, nutrients, some organic compounds, and emerging contaminants such as pharmaceuticals. As point and nonpoint discharge sources have been reduced in many areas of the United States in recent years, the water quality of rivers and streams has improved dramatically. This has led to the possibility that effective riverbank filtration can occur in this area. In Class AA waters, collector wells would not be expected to be contaminated with pharmaceuticals and other pollutants associated with sewage effluent, except that which has emanated from nearby septic systems in the watershed. However, in Class B sourced surface waters, these contaminants may become prevalent. The state has seen several incidents where wells pumping near streams have had adverse effect on streamflow levels during low flow periods. Thus, careful consideration must be given to the location and operating parameters of such wells.

Whether or not collector wells will be permissible for potable water in Connecticut remains to be seen. The state's process for evaluating groundwater under the direct influence (GWUDI) of surface water is quite rigorous, but many wells located near watercourses have passed the testing and been authorized for potable supply without filtration. However, the ability of a collector well to pass the GWUDI evaluation has not been tested. This will be important to determine in the near future, because it will help determine whether collector wells are potentially viable as drinking water sources. The state may need to look to other states that are using collector wells for potable supply, from near (New York) to far (the Midwest and beyond). If water from collector wells is not appropriate for drinking without treatment, the provisions of the SDWA would apply.

WP3-2.6. Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) involves pumping surface water underground into the aquifer for future recovery. Where aquifers are large and have the capacity for additional storage, this process can be used to store excess surface water runoff that would be unpractical or impossible to store in a surface reservoir, treated effluent from wastewater treatment plants, or excess drinking water from a public water supply system. ASR can be achieved via surface spreading, infiltration pits and basins, or injection wells.

ASR has not been used in New England, according to the EPA, primarily because the aquifers are not really extensive and because the depth to water is shallow. Even where ASR might be feasible, its use does have risks. Raw water injected into the aquifer may have pathogens, which could proliferate and require extensive treatment upon recovery. Additionally, chemical compounds in pre-treated effluent and drinking water can react with compounds in the aquifer, creating chlorinated compounds and other toxic byproducts. There are other issues with ASR, which can interfere with recovery, due to well clogs, and cause undesirable chemical characteristics of the water.

WP3-2.7. Water Banking in Connecticut

Interestingly, one of the state's first water banking operations was recently constructed, and it is the opposite of ASR. The City of New London will soon be storing (in its reservoir) water withdrawn from wells located in East Lyme, and then selling the water back to East Lyme when diversion permit conditions make it impossible to fully utilize the wells. Additional examples of water banking may be identified and explored.

WP3-2.8. Development of Additional Storage

Storage projects capture water during high flow years and seasons to be used during low flow periods. These storage projects include the construction of new reservoirs, enlargement of existing reservoirs, or rehabilitation of existing reservoirs that have reduced storage volumes due to various structural problems (e.g., spillways unable to meet the current probable maximum flood criteria, etc.).

WP3-2.8.1 New Storage Projects

New storage projects include the construction of dam embankments to create on-channel or off-channel reservoirs. Off-channel reservoirs require the construction of diversion or pumping facilities from the river on stream to deliver the diverted water to storage. Storage options will

vary greatly in their feasibility, while project considerations, such as firm yield, capital costs, and permitting are site specific.

The benefits of developing new storage projects include:

- Water sources will be diversified if the water to be stored is from a new source. This can reduce the risk of supply shortfalls as not all water sources may experience shortages at the same time.
- The reliability of the overall water supply system can be increased and the risks reduced. The development of additional new storage can help protect against potential water shortages due to structural failures such as storage restrictions of the temporary inability to use a supply due to water quality concerns.
- Overall system efficiencies are increased by minimizing system spills.
- There is the potential for hydropower generation.

The potential issues and conflicts in developing new storage projects include:

- There may be environmental impacts to the aquatic and terrestrial environment. These impacts could be more significant than those resulting from enlarging existing storage facilities.
- Loss of recreation associated with free-flowing streams, such as fishing, rafting, and kayaking.
- Water quality impacts can be associated with impounded water.
- Cultural impacts associated with inundation of lands.
- Permitting and mitigation can be more expensive and lengthy than other water supply options and have an uncertain outcome.
- A significant amount of storage may be required to produce substantial yield.
- Dam safety is already a significant concern in the United States, and these projects would lead to more dams.

WP3-2.8.2 Expansion and Reoperation of Existing Storage Facilities

The expansion and reoperating of existing storage facilities can be a cost-effective means to develop additional storage. Options for increasing storage in existing facilities include raising dam embankments, dredging sediments, and deepening reservoirs and raising spillway levels.

The expansion and reoperation of existing storage facilities has several benefits including:

- There are likely to be less environmental and recreational issues than for new storage, since the reservoir already exists.
- Permitting and mitigation requirements may be less difficult than for construction of a new storage facility.
- Overall system efficiencies are increased by minimizing system spills.

- Corps of Engineers Flood Control facilities can be expanded for water supply as a secondary use.

The potential issues and conflicts in expanding existing reservoirs include:

- Environmental and recreation impacts can also occur depending on the size of facility.
- Expanding existing storage facilities does not diversify water sources and the risks of structural failures or water quality catastrophes are not reduced.
- Permitting and mitigation, though typically less difficult than that for new storage, can still be expensive and lengthy with an uncertain outcome.
- A significant amount of storage may be required to produce substantial yield.
- There are a limited number of reservoirs that can be enlarged. Many reservoirs are not cost-effective to enlarge or have small watersheds that do not allow for a proper refill.
- There is a limited volume of increased storage available through reservoir enlargements.
- The enlargement of existing reservoirs may not be cheaper than new storage. The original dam embankments and spillways, in many instances, were not designed or constructed to current engineering standards. Upgrading the existing facilities to be compatible with an enlargement may not be cost-effective, given the heightened concerns about dam safety in the nation.

WP3-2.9 Flood Control Reservoirs for Water Supply in Connecticut

Because Connecticut allows public water supply from Class A surface waters but not Class B or lower quality, the number of flood control impoundments available for potential use as a public water supply reservoir is limited. However, one noteworthy example is Mansfield Hollow Lake. This impoundment has a normal pool elevation that allows for significant areal extent and volume. In contrast, many other flood control reservoirs in Connecticut do not maintain significant volumes behind the dams. Thus, Mansfield Hollow Lake has often been cited as a reservoir that should be considered for public water supply in the Town of Mansfield, potentially providing relief to the UConn area. Because UConn and the Town of Mansfield have elected to pursue other options for water supply (increased conservation, reclaimed water for non-potable uses, careful use of the two wellfields that supply UConn, and a regional pipeline from Tolland), further discussions related to Mansfield Hollow Lake as a direct source have ceased.

However, the question of using Mansfield Hollow Lake as a mitigating factor for the downstream Willimantic Reservoir (operated by Windham Water Works) is still quite germane. At some point in time, Windham Water Works will need to renew its water diversion permit, and this will call into question conditions of the Natchaug River. Although the current permit limit was found to cause only minimal impacts to fish habitats in the Natchaug River (based on an instream flow study), Windham Water Works may become an important hub for public water supply in the future if conditions in eastern Connecticut change. An increase in the diversion permit limit would likely necessitate a modification in the operation of the Mansfield Hollow Reservoir to retain and release water in a manner that benefits the ecological health of the Natchaug River.

There are few – if any other – examples of flood control impoundments upstream of water supply reservoirs. However, there are examples of flood control, recreational, and hydropower impoundments upstream of wellfields that lie along rivers. It is not too soon to begin thinking about these impoundments as potential mitigating factors for low instream flow conditions. If the impoundments could release water when the downstream public water supplies are needed most, instream flow conditions could be maintained or even improved.

One potential example where this arrangement could occur is along the West Branch Farmington River. The West Branch Reservoir is downstream of the flood control reservoir. The West Branch reservoir also maintains the flow in the Farmington River for fisheries, recreation, power and wastewater assimilation. There may be available water in the combined reservoirs for future supply.

It is important to note that if flood control reservoirs are used for public supply, supply would be secondary. In other words, if the operator needed to release water from the reservoir to create storage in anticipation of a major storm, this would happen without haste and the availability of supply could be affected if the impoundment did not refill quickly. This underscores the inherent conflict in reservoir management for the goals of flood control (water level to be kept low as possible for flood storage potential) vs. water supply (water level to be as high as possible as much of the time as possible for drought periods). This points back to the ideal situation at Mansfield Hollow Lake, where a normal pool elevation is maintained.

Aside from public water supplies, there are other potential uses of flood control impoundments in Connecticut. Non-potable uses such as power generation, golf courses, agriculture, nurseries, extraction (sand/gravel), and certain industries could utilize water from flood control impoundments while avoiding significant adverse environmental impacts that would occur due to equivalent withdrawals from free-flowing streams. The challenge would be the siting of these facilities near flood control impoundments, since the impoundments are often on state or federal land.

WP3-2.10. Flood Skimming and Storage in Connecticut

Flood skimming and storage refers to the diversion of water from a stream during high flow conditions to a separate surface water impoundment (i.e. not an impoundment located directly downstream). This can take advantage of the increased supply which would ordinarily flow downstream as runoff. Water can be pumped into large reservoirs which are not formed by impoundments of the source stream. Thus, a separate source of supply can be used to fill the reservoir, essentially using the reservoir as a storage tank.

While there was some discussion about using flood skimming back in the 1980s and 1990s, few examples can be found in the state.

Water utilities that own multiple reservoir systems with an interconnected transmission system may be able to apply the same concept as flood skimming by maximizing use of run-of-the-river reservoirs during typical high flow seasons (winter, spring), and reducing withdrawals from other reservoirs to promote refilling for serving high demands during summer months.

WP3-2.11. Stormwater Capture in Connecticut

Stormwater capture can be an effective method of collecting and then "producing" non-potable available water in a residential, commercial or industrial setting. This is also known as water harvesting. During a one-inch rain storm, a 10,000 square foot flat-roofed retail building can produce over 6,000 gallons of water. This water can replace potable water in such uses as irrigation, industrial cooling, and flushing toilets. Small cisterns holding 50-100 gallons are cost effective and readily available for residential use, which easily rest under or attach to gutter drain spouts. Larger systems holding several hundred to thousands of gallons are available as well, though at a higher cost and with more involved installation.

If pursued extensively in Connecticut, capture and use of stormwater would not be a comprehensive solution for multiple properties or neighborhoods. It would likely be used case-by-case to reduce the use of potable water supply through individual service connections to individual properties. Several examples of LEED-certified buildings that use stormwater for toilets and irrigation can be identified, including Kroon Hall at Yale University and the Milone & MacBroom, Inc. office in New Paltz, NY. The potable water needs of these buildings are therefore limited to drinking, cooking, etc.

WP3-2.12. Desalination

Desalination is the removal of salts from water to produce a water of lesser salinity than the source water. Other terms that are interchangeable with desalination include seawater or saline water conversion, desalting, demineralization, and desalinization. For consistency, "desalination" will be used in this chapter.

Desalination can be used to reduce salinity in many sources of water. The term source water is used to identify the body of water from which water is taken for beneficial purposes. On a national scale, source water for desalination can include surface water, groundwater, and municipal wastewater. Desalinated water can be used for potable uses, such as municipal drinking water, or non-potable applications, such as agricultural irrigation or industrial processes. The focus of this chapter is on desalination of surface water or groundwater for potable uses.

Sources of Water for Desalination

Typically, raw water sources must meet basic municipal water supply development criteria for quality and quantity. Municipal source waters should be capable of providing an adequate and sustainable amount of water for an intended beneficial use. Potential sources include oceans, bays, rivers, lakes, and groundwater aquifers. The determination of the safe yield from a water body is necessary for desalination as well as many other types of water supply projects. Oftentimes, ocean and other saline open-water environments afford the greatest safe yield potential for desalination.

Potential Benefits

Desalination can improve a water supplier's ability to provide safe and reliable drinking water to its customers. When adopted as part of a diversified resource portfolio, desalination can provide many potential benefits, including:

- Expanding local water supply.
- Improving overall supply reliability by diversifying resource portfolios.
- Providing emergency supplies during drought periods and after extraordinary events.

Major Implementation Issues

The major implementation issues associated with desalination as a viable resource management strategy can be placed in the following categories:

- Permitting and Regulatory framework.
- Energy use and sources.
- Climate change.
- Funding and perhaps more specifically, significant costs that must be paid by someone.
- Intakes and ocean and freshwater ecosystems.
- Concentrate (brine) management and disposal.
- Subsurface extraction.
- Planning and growth.

Desalination in Connecticut

Generally speaking, desalination has not been as popular in northeastern states as in the west because northeastern states have had more abundant water sources while water demand has not grown rapidly. There are not any desalination plants in Connecticut. In fact, the first desalination plant in New England was not completed until 2008 in Brockton, Massachusetts. This desalination plant provides more than 4 million gallons per day of potable water from the Taunton River. CT DEEP notes desalination may become more prevalent as technology improves and costs drop. However, desalination capabilities have yet to be pursued in Connecticut. Currently due to 22a-417 desalination is not a legal option for potable water supply since it is waste receiving, poses public health concerns, lacks protection of landuse control and water quality control.

The Town of East Lyme reportedly evaluated desalination several years ago as a potential source of water prior to pursuing the water banking arrangement with New London. East Lyme could be contacted for additional information if the State Water Plan process determines that desalination should be further explored.

3.2.2 Future Water Management Challenges

WP4-1. Overarching Challenges Inherent in Connecticut's Regulatory Framework

This section will examine certain challenges that will likely affect future water management because of the state's existing regulatory structure. Though they may pose challenges, these conditions are also in place for many reasons, and have yielded many benefits to Connecticut citizens and their way of life. Just as traffic laws are imposed to protect the public good, so too do they represent constraints on human activities that can, at times, be challenging. The characterization of the regulatory conditions, likewise, that may pose "challenges" in no way implies that they are to be altered or adjusted, but rather, that they should be understood and acknowledged in order to make informed decisions about water management.

WP4-1.1. Challenges Associated with "Home Rule"

A central tenet of life in Connecticut is the principle of "home rule," or a high level of management authority at the municipal level. Connecticut is divided into 169 municipalities[18] that administer their own land use regulations within the parameters of state statutes. All are required to develop a local Plan of Conservation and Development as described in Section 2.2.2. Some municipalities share services such as education (through regional boards of education) and health (through local health districts), but "home rule" is ubiquitous throughout the state's municipalities. In some cases, water is managed regionally (examples can be found in Section 2.2.2) but in the future, there are no clear guidelines or incentives for regionalization.

To be clear, these differences are often strengths that build community character and give people and businesses choices about where to be located. However, some of the longest-running water challenges in the state could not be solved without municipalities working together, such as the regional interconnection of water utilities in southeastern Connecticut. This regional approach in southeastern Connecticut has solved water imbalances [the provision of water from Groton Utilities to Montville and the Mohegan Tribe], improved cooperation during day-to-day as well as emergency situations [the Intra-Regional Water Supply Response Plan], and fostered future collaboration relative to identifying new sources of supply [the SCCOG subcommittee for water resources planning].

Despite the numerous benefits of local control and citizen involvement with local issues, home rule can pose certain challenges for managing water (this same governmental structure has certainly hindered regional and statewide planning in neighboring Massachusetts). Consider the following examples:

- Because municipalities are enabled by the state to form municipal water departments and water pollution control authorities, water and sanitary sewer service areas are often

[18] Although the figure of 169 is often cited, the number is higher when separate municipal jurisdictions are included (Town and City of Groton, Town and Borough of Stonington, Town of Griswold and Borough of Jewett City, Noank, Groton Long Point, Fenwick, etc.).

coincident with municipal boundaries, leading to the existence of many moderately-sized water and sewer service areas in some parts of the state.

- Many of the municipal water and sewer systems are, in turn, surrounded by towns without water or sewer service; or towns that are part of regional water and sewer authorities. This leads to vast differences in how water and wastewater is managed over the span of as little as three adjacent towns that could otherwise be competing uniformly for economic development opportunities and other amenities. Examples of adjacent towns with different water and wastewater situations include Cheshire [regional water supply and municipal sewers],Wallingford [municipal water and sewer], and Durham [limited municipal water service and no sewers]; Ridgefield [regional water supply], Danbury [municipal water and sewer], and New Fairfield [many small water systems and no sewers]; and Manchester [municipal water and sewer], Vernon [regional water supply and municipal sewers], and Bolton [several small water systems and a desire for expanded sewers].
- Potentially regional solutions to water supply and wastewater problems are not always recognized or supported by municipalities (or incentivized, monetarily or otherwise) as the municipalities attempt to solve problems internally.
- Different municipalities typically manage drought response differently, and a few have drought ordinances while many towns do not. This can be especially challenging when a regional water utility serves more than one town. Additionally, municipalities are the only entities with enforcement authority until emergencies are declared.
- Municipalities with sanitary sewer service and municipalities that are sewer avoidance towns are sometimes side-by-side, making it difficult to equitably attract businesses or provide services.
- Stormwater management ordinances usually vary from one town to the next, with vast differences in requirements for collecting, conveying, treating, detaining, retaining, and discharging stormwater. In addition, municipalities are individually responsible for dealing with MS4 mandates that are often confusing and, at the present time, changing.
- Low impact development has been embraced by some municipalities but not others.

This is not a critique of home rule, but an acknowledgment of this way of life in Connecticut, and an effort to raise awareness that it can pose interesting challenges to centralized planning and policy implementation.

WP4-1.2. Levels of Authority Going Forward

There is uncertainty in the future roles, responsibilities, and levels of authority of the Water Planning Council, and indeed of the state agencies with respect to implementing the recommendations in the Plan. Refer to Section 2.2.1 for an overview of the existing Water Management Framework in Connecticut. One of the objectives of the State Water Plan is to develop an implementable plan with an effective management structure. The challenges of meeting this objective include the following:

- Authority established by current law provides sometimes overlapping oversight on water resources that results in conflicting drivers.

- Revising the roles of state agencies or encouraging cooperative decisions can sometimes be impractical or with resistance.
- There is no current model for making large-scale consensus-based recommendations on water policy in Connecticut, and a central challenge of the Plan development process (shared by the WPC, the state agencies, the stakeholders, and the consultant) is to develop such a framework that will be influential, even persuasive, at the legislative and executive levels within the state so that future laws and regulations will carry broad support.
- The Water Planning Council will need specific roles and authority during the implementation phases of the Plan, both for the purposes of advocacy and actual follow-through with the Plan recommendations. The challenge of being limited only to give advice to the legislature may become a hindrance, as many initiatives may not actually require changes in laws or regulations, but rather take the form of incentives, partnerships, joint funding pursuits, and guidelines for local response to statewide initiatives.

WP4-1.3. Future Challenges Associated with the Prohibition of Class B Waters for Drinking

Note: This topic could fit into either category, as its challenges are inherent to Connecticut's regulatory framework, but also specifically related to drinking water. However, because so many other uses rely on water provided from utilities that treat Class A water for both potable and non-potable uses, it is included as an overarching aspect of the regulatory conditions in Connecticut, as it will affect many decisions and recommendations.

As portrayed in Section 3.2.1, Connecticut uses only Class A or Class AA surface waters for human consumption, pursuant to Section 22a-426 of the Connecticut General Statutes. Withdrawals for human consumption are not allowed from Class B surface waters (or lesser quality) as these may receive treated wastewater (some of which originates outside the state and therefore outside the state's jurisdiction). For example, the Connecticut River is not used for drinking water purposes because treated wastewater is discharged into the river and it is Class B. This rule has been a mainstay in Connecticut, the only state in the United States in which this form of public health protection is the law. As a result, public water supply customers benefit from lower risk of consuming contaminants associated with water bodies more susceptible to eutrophication, industrial wastewater, and discharges of sewage effluent. In addition, it is presumed that many of the state's residents are avoiding the potential ramifications of consuming many emerging contaminants such as cyanotoxins and pharmaceuticals.

Additionally, the state's water utilities can experience lower costs for filtration and treatment of surface water compared to other states where Class B waters can be used for drinking. Additionally, treating more degraded raw water to drinking water standards could involve more energy intensive treatment processes, such as DAF and ozonation, and this could, in turn, affect air quality and climate trends.

Since water has historically been plentiful in Connecticut, the limitations on the use of Class B waters has not imposed significant stress on the state's water supply. However, the advent of future conditions, some certain and some potential, could render the Class B restriction as a challenge. For example, the new instream flow requirements (see Section 2.2) will likely render

fewer Class A and AA watercourses available for drinking. Likewise, if registered diversions are used to their full extent in certain basins where they are currently not fully used (see Section 2.1.1), even less water could be available for other uses. Class B waters may be relied upon more heavily for non-potable uses, requiring infrastructure that is not necessarily in place today. In these ways, the restrictions on Class B waters pose some unique challenges to *future* water management:

- Headwater streams and moderately sized rivers are being relied upon for supply to many of the largest water utilities in the state such as MDC, RWA, Aquarion, Connecticut Water Company, Waterbury, New Britain, Bristol, Groton Utilities, Norwalk First Taxing District, SNEW, New London, Norwich Public Utilities, Wallingford, Manchester, Danbury, Windham Water Works, and others. Because of other demands on this water (instream ecological flows and potential exercising of registered withdrawal volumes), these headwater streams could see less water available for other future uses. Even today, the flashiness of headwater streams has led some water providers to either build reservoirs or rely upon nearby alluvial aquifers because storage can help sustain supply through drier periods.
- Because headwater streams and moderately sized rivers are being relied upon for supply to many of the largest water utilities in the state, sections of streams that are likely to become more flow-impaired are often found in the upstream reaches of river systems while some lower sections of river systems are less vulnerable to flow alterations or, generally speaking, not likely to be impaired because of many tributaries and wastewater return flows. However, in some cases, downstream river reaches are vulnerable to other pressures caused by development; impervious area, stormwater runoff, etc.
- When developing new sources of water supply, the state's water utilities have looked to groundwater supplies and interconnections rather than attempt to develop new diversions from the Class A watercourses, which are relatively smaller than Class B watercourses. This has led to a sometimes complex pattern of interconnections in the state, plus large areas of groundwater supply development along rivers and streams of various sizes. While this paper does not cast such practices either positively or negatively, they do reflect an important point: The suite of available options for future supply is limited.
- Because headwater streams and moderately sized rivers are being relied upon for supply to many of the largest water utilities in the state, vast areas of rural land are held by water utilities for protection of public water supplies and therefore protected from development. This is not likely to ease in the future, especially as additional water demands are placed on these headwater streams in the form of ecological flows and registered diversions.

WP4-1.4. Public Uncertainty

Any effective water plan must conscientiously blend legislative initiatives with grass roots needs at a local level. While the project team, participating state agencies and WPC committees will collaborate in advertising opportunities for public citizens to ask questions and comment on the plan and the planning process via public forums and decision-making workshops that are open for public viewing, the actual level of engagement is beyond the control of project participants. Certain recommendations in the Plan may meet with resistance in the legislature if constituents raise concerns about lack of involvement or inadequate understanding of the decisions and their

impacts. This challenge is not unique to Connecticut, but the concept of home rule in the state can exacerbate this challenge – just over the border in Massachusetts many statewide and regional initiatives have been resisted by individual communities who press instead for the status quo in the face of uncertain future pressures or restrictions.

WP4-1.5. Data or Other Resource Gaps that Limit Understanding of Water Resources and Needs

Data gaps are a key challenge in the context of water management because the lack of data (whether unavailable or inexistent) leads to uncertainties that can impede decision-making. A separate memo that explains data gaps has been prepared, and is available as a draft section of the State Water Plan. The State Water Plan will need to be developed while attempting to minimize the uncertainties associated with data gaps. At the same time, the State Water Plan should set priorities for addressing and correcting data gaps.

Connecticut is somewhat unusual in that much of the data that is publicly available in other states is protected for security reasons. While it may not be a significant challenge in the Plan development to not know exactly where specific water intake facilities are located, the lack of certain information on actual water consumption (either because it is protected or not reported) will be a major challenge in identifying the basins that could experience the most stress in the future (risk of not satisfying all instream and out-of-stream needs), and understanding how these basins could benefit from alternative management strategies.

WP4-1.6. Funding Sources and Constraints

Identification of funding sources will be a challenge for future water management in Connecticut. Like many states, Connecticut is facing challenges of increasing budgetary stresses with a limited tax base. This has contributed directly to loss of funding associated with projects that involve water management. For example, a town in western Connecticut was eligible for funding through the DEEP Potable Water Program to extend water service to properties with potentially contaminated well water supplies, but received word in spring 2016 that the State Bond Commission would not be capable of funding the project. The project had many benefits aside from the provision of a safe drinking water supply; it would have allowed several non-community public water systems to be retired, and would have provided interconnections to two nearby community water systems.

The traditional methods of funding water-related projects in Connecticut (CWSRF, DWSRF, municipal bonds, water revenues, private water utility funds, etc.) will likely continue into the coming years. However, additional sources of funds will need to be identified. It is reasonable to assume that the state may contribute to future innovative water projects, just as the state funded the reclaimed water facility at UConn.

Many opportunities appear to be emerging for investments in “green” projects. In the coming years, the state could monitor the availability of projects that can be funded, in part, by investments in green projects.

WP4-1.7. Economic Impacts – The Challenges of Estimating Future Impacts and Benefits of Decisions

One of the challenges for future water management in Connecticut related to funding is that costs are often easily estimated but benefits are not easily estimated. Many federal funding programs (FEMA, U.S. Army Corps of Engineers) require benefit cost ratios above 1.0 before funding can be considered. While this is not directly applicable to DRSRF and CWSRF projects, the assumptions are that project benefits are tangible. An important caveat to federal funding is that benefits are often monetized, and water management decisions cannot always be equated to impacts or benefits in the form of dollars. Understanding whether decisions will likely encourage or hinder economic development on a subjective basis is usually intuitive, but quantifying economic potential will always be a challenge, especially if economic impacts of statewide or regional decisions could affect municipalities in different ways. Complicating this further is the fact that so many benefits of water management decisions (environmental stewardship, ecological restoration, aesthetic, etc.), while interconnected with a region's economy, are often based more solidly in human values and priorities, which cannot be monetized.

Aside from evaluating the impacts in terms of economic development potential, there is also the basic evaluation of cost and cost avoidance which factors into water management decisions. Even these can be complicated and prove to be challenging. An example taken from the public sector is the UConn reclaimed water facility. The cost of the project consisted of a fixed portion (design, construction) and currently includes the ongoing operations and maintenance. There is a cost to produce reclaimed water that can also be calculated. The benefits are clear but estimating their values is not straightforward:

- Benefits associated with pumping 500,000 gpd less, taken from the Willimantic River wells, assuming the Fenton River wells are shut down; as is, typical in many summer to fall seasons.
- Benefits associated with 0.8 cfs of water remaining in the Willimantic River (assuming that the water saved by using reclaimed water has not been repurposed).
- Benefits associated with the project potentially serving as a model for other reclaimed water facilities in the state.
- Benefits associated with freeing potable water for higher/better uses on campus.

It may be advisable to begin developing a process to estimate the dollar values associated with the benefits of future water management programs and projects in Connecticut. FEMA, the U.S. Army Corps of Engineers, and NRCS can all be contacted for information about how they have incorporated environmental benefits into their evaluation tools. These processes can work well for specific projects (for example, miles of stream buffer zones improved), but at a statewide policy level it is more challenging. And it will also be important to include the benefits that have more to do with public and environmental health, quality of life, and ecological restoration potential which are not easily translated into dollars.

WP4-1. Challenges Unique to Certain Water Uses or Sectors

This section focuses on specific future challenges to water management alternatives that seek to improve specific water uses (ecological needs, water supply needs, etc.) or sectors of the water environment (surface water, groundwater, or reclaimed water, for example). Unlike Section 1.0, these challenges arise less from the regulatory and legislative history in Connecticut than they do from the current balance of water supply, water quality, and all of the state's water needs. While the regulatory framework and legislative history are certainly related to the issues in this section, these discussions focus more specifically on individual water needs and the way the regulatory decisions may affect the balance between water supply and water needs, which is different than the impacts from the regulatory structure on its own.

WP4-2.1. Water Allocation

WP4-2.1.1 Registered and Permitted Diversions

The Water Diversion Policy Act of 1982 attempted to more strongly regulate withdrawals and alterations to flow by establishing a permit requirement for any out-of-stream or instream diversion from a water source greater than 50,000 gallons per day. However, any diversion registered by July 1, 1983 was exempt from the permitting requirements of this Act. Approximately 1,800 registrations of exempt withdrawals were recorded, which are valid in perpetuity. Many water withdrawals were registered for vastly greater amounts than they have used since that time. This has reportedly made it challenging to allocate water in Connecticut.

However, water registrations have been relied upon for many years because of the benefits they offer to water users:

- They ensure supply adequacy for many water users
- They allow water use in some places where environmental consequences may be significant, but the need for water is very great and there has been a need for balance. Most of the water supply reservoirs are registered, and they provide storage to buffer persistent dry periods.

The "Situation Assessment in Support of State Water Planning Workshop" memorandum (June 25, 2015) described some of the following challenges to registered and permitted diversions, both present and future (it also states some opinions and recommendations, which are not included here):

- Registrations have created situations that could result in over-allocation in some basins if the registered volumes are actually withdrawn.
- Registrations do not necessarily reflect actual water withdrawals. In many cases, they represent the instantaneous capacity of the intake facilities, and not a continuous average daily withdrawal. However, they could be exercised continuously at full capacity in the future even if they have not been historically.
- Registrations are still listed for defunct water users.
- The registration process lacked consistency in the methods used to determine registered amounts.

- Data on registered and permitted diversions are critical for a meaningful evaluation, and the difference between actual usage and registered/permitted usage are not always readily available.

Fundamentally, the future challenge associated with water registrations in Connecticut is that without a major reversal of state law, basins may have a perpetual surplus of unavailable (but usable) water, or recurring shortfalls if the registrations are all exercised. Even small steps in revising registered volumes downward toward more accurate reflections of actual water need may be viewed as an infringement. This is both a political and hydrologic challenge.

WP4-2.1.2. Private/Industry Water Uses (i.e. power plants, manufacturing, bottled water)

One of the impacts of de-regulation of the electrical industry more than ten years ago was the development of power development facilities in the state. Some of these facilities have required water commitments from nearby public water systems for active daily supply as well as potential peaking supply, and there is often a large discrepancy between these figures. Power generation facilities are proposed or pending in Oxford (gas-fired) and Beacon Falls (fuel cell), and both will rely on nearby public water systems for non-potable uses. Section 3.2.1 discusses the potential options for supplying power generation facilities ("Use of Class B Water for Non-Potable Sources" and "Reclaimed Water for Non-Potable Uses"). Further discussion is needed regarding how to most effectively and efficiently provide water to power generation needs.

Many of the new and emerging industries in Connecticut (specialty manufacturing, research and development, bottling plants, etc.) are selecting locations that are within or adjacent to large public water distribution systems, and could therefore be supplied by these public water systems. When this occurs, the water that will be utilized by the new customer has already been regulated pursuant to the Water Diversion Policy Act because the public water system is either registered, permitted, or both (some combination of registered and permitted sources). Customers are not further regulated by the Water Diversion Policy Act unless they are legally considered separate public water systems (typically with their own PWSID), but this type of arrangement is infrequent.

In recent years, there have been several examples of proposals that have caught the public's attention due to the volumes of water proposed for those customers. Going forward, public water systems are obligated to serve the new customers that arise in their service area regardless of the intended use of the water supplied, and municipalities are obligated to review land use applications in their boundaries. But in any venue, new large water uses can pose challenges in river basins, especially if primary sources have historically been Class A or AA for both potable and non-potable uses. The state may benefit from guidance about how to work with communities to site and permit new large water users while considering economic development plans and needs. This connects back to the challenges associated with home rule, where municipalities are often competing for new developments.

WP4-2.1.3 Cumulative Effects of Water Withdrawals Below 50,000 gpd

Thousands of public water systems in Connecticut (small community, TNC, and NTNC systems) withdraw less than 50,000 gpd each, and are therefore not regulated under the Water Diversion Policy Act. In addition, hundreds or thousands of non-potable water users (rural commercial and industrial users, nine-hole golf courses, small nurseries and farms, and residential irrigation from streams) use less than 50,000 gpd (each) and are similarly not regulated by the Water Diversion Policy Act.

The cumulative impacts of water withdrawals that are each less than 50,000 gpd are not quantitatively known. It is suspected that cumulative impacts are less adverse in areas where water is returned via subsurface sewage disposal systems, but this may not always be the case. Likewise, sewered areas are typically believed to be adversely affected by the export of water, but this may not always be the case either. Cumulative withdrawals have not been summed and compared to the hydrology of different drainage basins.

Future water management amidst uncertain cumulative withdrawals is complicated further by the thousands of private groundwater wells in the state. Some towns rely exclusively on private groundwater wells. The unknown volumes of private groundwater used for residential or commercial consumption and irrigation can only be estimated at this time.

Hence, the unknown volumes of water withdrawals that use less than 50,000 gpd, coupled with the undocumented volumes of private well withdrawals across the state, pose a significant challenge to understanding which basins could experience the most stress in the future (risk of not satisfying all instream and out-of-stream needs), which are most vulnerable to action or lack of action, and which could most benefit from specific recommendations in the Plan.

WP4-2.2. Instream Flow Needs

WP4-2.2.1 Situations Where Instream Flow Needs are not Considered

The Streamflow Standards and Regulations intended to address the artificial regulation of instream flows downstream of impoundments by classifying streams and river by degree of human alteration, and subsequently requiring certain releases from impoundments. This process will result in achieving different instream flow patterns below impoundments with registered diversions, with the intent of offering ecological benefits because the required releases will more closely mirror "natural" conditions. One impact of implementation may be reductions in safe yield of public water supplies that leads to a need for supply augmentation. This could include a reliance upon new interconnections and interbasin transfers, new source development, and water conservation programs. The challenge is that the ecological flows must be balanced against the demand for water for other uses. Competing water demands (out-of-stream and instream[19]) may be more prevalent in Connecticut's future than they have been in the past.

[19] The terms "out-of-stream" and "instream" water use can be interpreted in different ways. For the purposes of this paper and the State Water Plan, "out-of-stream" water use refers to water use that removes water from its natural environment (a stream, reservoir, aquifer, or other water body) while returning it elsewhere, fully or as a percentage of what was removed. "Instream" water use shall refer to water that remains in the stream for uses such as recreation, ecological health, and aesthetics.

However, the Streamflow Standards and Regulations provide for many exemptions. According to the regulations summary, the following uses are exempt from the restrictions of Sections 26-141b-1 to 26-141b-8:

- Hydropower under FERC
- Fire emergencies
- Flood control dams
- Dams not on streams
- Permitted diversions
- Diversions subject to approved flow management plans such as special act or wild and scenic designations
- Tidal rivers
- Impoundments with no active manipulation or withdrawal (these are typically lakes and ponds used for recreation or other instream purposes)
- Small intermittent withdrawals
- Drawdowns for dam inspection and weed control
- Agriculture and golf courses
- Dams with watersheds less than 3 square miles or naturally limited flows
- Certain streams between reservoirs

The reasoning behind these exemptions is that the interruptions in streamflow are either temporary, or the inflow to the impoundment is similar to the outflow, or the environmental conditions have been reviewed through the diversion permit process or FERC licensing process. Therefore, these exemptions likely will not cause or allow adverse instream flow conditions to continue, in most cases. Other exemptions exist as well, such as streams whose flow is low enough that the required flow remaining in the stream by statute would be 0.1 cfs or lower.

Instream flow can be affected by groundwater withdrawals. At the basin scale, the net effect of groundwater withdrawals includes reduced discharge to streams and rivers. At a more localized scale, the effect can include reduced discharge and induced infiltration. The diversion permit process includes a review of impacts, but the registration process did not (as noted above). Therefore, there are many groundwater withdrawals in Connecticut that may be causing adverse impacts to instream flows. A drafted version of the Streamflow Standards and Regulations – which was not passed – included provisions for cutting back groundwater withdrawals to protect instream flows.

Discussions about instream flows are typically dominated by concerns related to surface water and groundwater withdrawals. However, land use can also affect instream flows. Mounting evidence has demonstrated that the proliferation of impervious surfaces will make streams flashier, increasing high flows while reducing groundwater recharge to the extent that it causes reductions in base flow discharges to streams. Land cover is one of the factors in the classification

of streams pursuant to the Streamflow Standards and Regulations, but it doesn't directly affect required releases. LID techniques (discussed in this paper and others) better maintain natural conditions that act to infiltrate precipitation to the groundwater system, and subsequently available for discharge to streams. It may be a challenge to change land development in Connecticut going forward, to incorporate additional LID methods that benefit instream flows, because the direct benefits are difficult to see or understand and because land development is regulated at the local level.

WP4-2.2.2 Streams on the Impaired Water List (Clean Water Act Section 305(b)) that are Flow-Impaired

The Impaired Waters list (described in Section 2.2.1) is updated periodically and typically includes identification of stream segments that are flow impaired (or believed to be flow impaired). The 2014 edition of the list notes the following:

> "DEEP documents streams and rivers affected by impoundments and water diversions as they come to our attention, however DEEP has not conducted a comprehensive assessment of flow impairments. Flow alteration has been reported as an impairing cause in stream segments with known water diversions and documented dry streams, primarily by field staff during sampling events and recorded by digital photos. For example, a number of stream miles, as in the lower Farmington River and the entire Quinebaug River, are affected by extreme fluctuations in water levels resulting from hydropower generation. DEEP staff have documented flow impairments on 1.4% of river miles, but 98.6% (2,333 river miles) are currently unassessed for flow."

Nevertheless, Table 3-7 of the 2014 report lists the watercourses that are believed to have "nonpollutant impairments." Approximately 20 of the listed stream segments are believed to have altered flow conditions that are causing the impairment. This list may be an important consideration for the State Water Plan, because the challenge may be that future needs may not all be met by historically available sources. It is understood that the 2016 edition of the impaired waters list is forthcoming, and additional information may be available.

WP4-2.2.3 Identification of Existing Studies and Plans

Many instream flow studies have been conducted in Connecticut over the years. Notable rivers and streams that have been studied include the Willimantic River near UConn, the Fenton River near UConn, the Natchaug River downstream of the Willimantic River, the Shepaug River downstream of the Waterbury water supply reservoirs, the Farmington River downstream of the confluence of the east and west branches, the Pomperaug River, and the Quinebaug River in northeastern Connecticut. The instream flow studies for these rivers have been conducted for different reasons with perhaps varying goals, but most of them quantified the impacts of low flows on fish habitats. It would be ideal if all of the instream flow studies prepared in the state were catalogued and filed in a central location for easy access and therefore available to use when making decisions about water withdrawals and other actions that affect instream flow. The challenge is that the information is currently not centralized.

DEEP is in the process of identifying additional instream flow studies that have been conducted, including the Little River in Putnam, Pattagansett River in East Lyme, Menunketesuck River in Killingworth, and the Eight Mile River.

The existing flow management plans and compacts in the state (Willimantic River, Fenton River, Farmington River, Quinnipiac River, and others) have been relatively successful in maintaining minimum instream flows in these watercourses. The implementation of the Streamflow Standards and Regulations over the next ten years may lead to development of additional flow management plans and compacts.

WP4-2.2.4 Planning for Locations of Future Studies, Plans, and/or Compacts

The State of Connecticut appears to lack a process for promoting, funding, or otherwise instigating the completion of additional instream flow studies. Likewise, the development of streamflow management plans and compacts are left up to the regulated communities and there are examples of such cooperative efforts throughout the state. A consistent approach to prioritizing instream flow studies in the state would be ideal because streams could be assessed quantitatively rather than relying on anecdotal evidence that adverse impacts are occurring. The impaired waters list could be used as a starting point for prioritizing locations for studies. Additionally, areas downstream of impoundments could be identified for completion of instream flow studies prior to the full implementation of the Streamflow Standards and Regulations.

WP4-2.3 Public Water System Issues and Challenges

WP4-2.3.1 Coordinated with WUCC WSA reports

The three Preliminary Water Supply Assessments (WSAs) were subject to public review in autumn 2016 (one for the west region, one for the central region, and one for the east region). The three final WSAs will be approved in December 2016. Each WSA report ends with a chapter that presents issues and challenges in the region. These are the categories:

- Future Supply Sources
- Impacts of Streamflow Regulations
- Coordination of Planning
- Movement of Water through Interconnections
- Development of New Interconnections
- Well Water Quality
- New Public Water Systems
- Viability of Small Water Systems
- Challenges of Operating Small Systems
- Disjointed Service Areas
- Exclusive Service Areas
- Source Water Protection

- Impact of Existing and Future Anticipated Regulations
- Continued Impacts of De-regulation of Electrical Industry
- Declining Revenue and Increasing Costs
- Conservation
- Lack of Fire Protection
- Infrastructure
- Lack of Funding

It will be important to review the issues and challenges identified in the context of public water systems (which is what the WUCCs are about) and determine which should be explored in the State Water Plan.

WP4-2.3.2 Regionalization of Small Public Water Systems

The very large number of small public water systems in the State of Connecticut is viewed by some as an inefficient method of providing water supply. Furthermore, the viability of these systems is an issue of concern, and they are potentially vulnerable to droughts because of limited storage and the duration that storage can sustain supply when rainfall deficits develop. A struggling or failed small public water system causes unacceptable risk to public health. Several sets of challenges facing the state include:

- Eliminating small systems may be possible in communities where larger public water system expansions have occurred, and therefore these larger systems are now adjacent to small systems. Barriers to connecting small systems to larger systems (thus eliminating the small separate systems) include lack of funding, lack of interest from the small system, potential changes in water quality, and potential changes in pressure.
- Many small water systems are owned and operated by entities not in the business of providing water. For example, there are many community water systems in Connecticut that are owned by (and contiguous with) private boarding schools. These schools have education as their chief objective, and may not be interested in water system management. However, with infrastructure in place, there may be little incentive to regionalize.
- Many large water utilities own and operate numerous small systems. Operational requirements, such as regulatory permitting, technical assessment, system maintenance, infrastructure replacement, and water supply need place a heavy burden on these water utilities, some of which operate multiple disconnected systems. A disproportionate amount of time and money is required to properly operate small systems.

Barriers to consolidation or regionalization of small water systems include cost, engineering considerations, the influence of local home rule, regulatory and public opposition to large system expansions or interconnections, and consumer preference.

At the same time, there are many areas in Connecticut that are completely devoid of public water system coverage, but the presence of a public water system is desired. Small systems will tend to be created in these areas over the long term, adding to the number of small systems even if others are consolidated or connected to larger systems.

WP4-2.3.3 Impacts of Changes in Water Consumption

Water conservation (described in Section 3.2.1 Water Management Alternatives) clearly results in reduced consumption, and the retention of water in storage or in streams where it can serve multiple needs. With continued conservation, however, water systems and customers have been challenged by declining revenue. This has, in some cases, made paying for infrastructure more challenging. Declining revenue can also provide a disincentive for additional conservation, presenting another challenge. Examples can be found throughout the state. Creative solutions are needed to recapture lost revenue and/or pay for maintenance and improvements. An example the water revenue adjustment process available for PURA-regulated water utilities as tool to address lost revenues.

It is important to note that there are sometimes differing views between privately-owned (PURA-regulated), municipal, and regional water utilities about whether costs for infrastructure can or should be borne by ratepayers or through grants that are funded by the general taxpayers for the benefit of a limited portion of the population.

WP4-2.4 Watershed and Aquifer Protection Where Incentives Are Lacking

WP4-2.4.1 Coordination and Consideration in Headwater Areas

Because the State of Connecticut does not allow withdrawal of Class B quality (or lower quality) surface waters for public water supply, water utilities in Connecticut have traditionally focused on acquiring land in rural areas where Class A streams are present. These areas have been acquired for reasons such as source protection (public water supply watershed protection) and future potential supply development. The Class A streams in these rural areas are often headwater streams (perhaps first order or second order). Communities in these areas have typically benefitted from the constraints on development in these areas of public water supply protection and future potential sources.

With the enactment of the Streamflow Standards and Regulations and its early phases of implementation underway (classification of all watercourses), most of the streams in the areas of public water supply protection and future potential sources are being designated Class 1 or 2. The intent of Class 1 and Class 2 stream flow classifications is to be protective of the quantities in headwater streams, thereby protecting existing and future downstream drinking water supplies. If there is sufficient quantities of water in class 1 or 2 streams, they can be re-classified to class 3 if needed.

Streams that have quality suitable for public water supply will not likely be used for public water supply. This will push the state to identify other solutions, such as those discussed in Section 3.2.1 Water Management Alternatives.

Water utilities that have an inability to use headwater regions for public water supply may dissuade water utilities and communities from protecting these areas. This is because it is

difficult to justify to ratepayers the incurring costs for lands that do not provide a benefit for public water supply. Without protection for the purpose of public water supply watershed protection (or future source protection), other tools may be needed to protect the rural headwater regions of the state.

A related challenge is that water utilities that have spent significant funds to preserve headwater areas may view this long-term investment as wasted, if these areas are no longer available for water supply.

WP4-2.4.2 Ground Water Outside "Ground Water Protection Areas"

As explained in Section 2.2.1, the State's Ground Water Protection Area Program is designed to protect the areas of contribution to existing wells developed in stratified deposits (sand and gravel aquifers) that supply over 1,000 people. Proposed wells are not included in the program until such time that water utilities develop these wells and secure approvals from DPH and DEEP for use. Municipalities that have jurisdiction over land in the Ground Water Protection Areas are required to adopt regulations for these areas. The regulations are based on the state's model regulations. The program has provided critical protection for the state's most important public water supply aquifers, but it is fundamentally an enhanced wellhead protection program. The program does not protect aquifers that are not used for public water supply.

Municipalities in Connecticut are entitled to protect ground water systems through other means, such as separate sets of regulations. For example, applicants for land use proposals that are located over the Pootatuck aquifer in Newtown must prepare evaluations of how the development will or will not affect certain aspects of the aquifer. However, many municipalities do not maintain separate sets of regulations for their sand and gravel aquifers. The State of Connecticut should determine whether there is a need to incentivize (monetarily or otherwise) additional protections in municipalities, especially given the preference of the municipalities for home rule land use regulation.

WP4-2.4.3 Land Use Practices (i.e. LID)

LID is described in Section 2.2.1 (Current Water Management Structure) in the context of existing water management structures and programs in Connecticut. A recently published report "State of LID" from UCONN can be found here: http://nemo.uconn.edu/publications/2016stateofLID.pdf

There are existing statewide barriers to LID, which are unrelated to watershed protection. The above-referenced paper explains that some specific barriers are cost (or perceived cost), the lack of educational opportunities for various participants in the land use planning process, and maintenance required after LID is utilized. Other obstacles cited in the report include municipal staff resistance, lack of resources, the lack of economic incentives for LID, the need for clearer or stronger state guidance, and the difficulty of collaboration (between departments within one town or across town lines). As explained in Section 2.2.1, DEEP is in the process of evaluating the incorporation of LID principles into the state's Stormwater General Permits, the Connecticut Stormwater Quality Manual, and the Connecticut Guidelines for Soil Erosion and Sediment Control.

There are also situations where these may be barriers to LID in public water supply watersheds and over important aquifers. For example, some municipalities (e.g., Newtown) limit or prohibit

infiltration of stormwater above certain aquifers. Other municipalities (e.g., Groton) have found it necessary to limit infiltration on a site within a public water supply watershed.

In general, LID is already challenging to promote and implement outside of public water supply watersheds and aquifer protection areas. It can be even harder to gain support for LID within public water supply watersheds and aquifer protection areas. However, LID is not a "one-size fits all" solution to water management, as a practice that benefits water quality in one application may cause an impairment in another, and these nuances should be explored at local levels.

WP4-2.5 Water System Vulnerabilities and Security Issues

WP4-2.5.1 Changes Over Past Few Years

More than 15 years ago, Individual Water Supply Plans prepared by water utilities were available for public review. Sanitary Surveys and other sources of public water system information were also open to the public. Since the terrorist acts of 2001, the state's freedom of information law was amended (Section 1-210; Access to public records; Exempt records) to exclude the following from being made public: vulnerability assessments and risk management plans; operational plans; portions of water supply plans submitted pursuant to section 25-32d that contain or reveal information the disclosure of which may result in a security risk to a water company; inspection reports; and technical specifications and other materials that depict or specifically describe critical water company operating facilities, collection and distribution systems or sources of supply.

In the years subsequent to this change (approximately 2003 to the present time), State Agencies have directed members of the public to approach water utilities for information, or have provided heavily redacted documents. Water utilities have handled information requests differently, with some allowing the public to view (but not copy) information and others requiring that release forms be signed.

In the last few years, security concerns and the ability to obtain water utility information has ramped up due to the Water Utility Coordinated Committee (WUCC) process (described in Section 2.2.1 and below) and the legislation that authorized development of the State Water Plan. The Connecticut Water Works Association (CWWA) produced a key memo in November 2015 that articulates the types of information that the water utilities are comfortable sharing. The challenge is that not all information that is typically available for statewide water plans will necessarily be available in Connecticut.

WP4-2.5.2 Proposals for Legislation

During the 2016 legislative session, a series of discussions between environmental groups, CWWA, and other entities occurred with the potential goal of modifying the FOIA exemptions regarding water system information. The bill was raised for a public hearing, but was not voted on by the Public Health Committee. Although a bill was not advanced, there is much anticipation in the state that modifications to the FOIA law exemption will eventually be taken up by the legislature and will be enacted. In the meantime, the most recent 2016 negotiated bill language can serve as guidance for evaluating the suitability of water utility information for public release.

WP4-2.5.3 Upcoming Effects of the WUCC Process

As explained in Section 2.2.1, the WUCC representing each public water supply management area (PWSMA) convened in June 2016 with the goal of developing new coordinated water system plans over the two-year process from June 2016 through June 2018. The WUCC process is required by Statute and Regulations to include public comment periods for several different phases, with the first phase (Preliminary WSA) taking place in August and September 2016. DPH and the WUCCs have committed to producing documents that can be fully shared with the public without any need for redactions. This is in stark contrast to the individual Water Supply Plans, which are exempt from the provisions of FOIA.

With the publication of the Preliminary WSA for the west, central, and east regions in mid-September 2016, residents of Connecticut now have access to basic water utility information that has not been readily available for several years. This will continue with the Integrated Reports in 2017-2018. Nevertheless, specific locational information will not be made public and specific information about various water utility assets, including components will not be published. At this time, this is not seen as a major hindrance to the State Water Plan, which will rely on regional summaries of water use and availability, rather than on individual utilities.

Although certain information will always remain secure and exempt from FOIA, one potential result of the WUCC process may be the fostering of a new era of information-sharing between water utilities and the public. This may happen more quickly, and perhaps more easily, than legislative changes.

WP4-2.5.4 Access to Data

The secure nature of data contained in Water Supply Plans and other water utility documentation has slowed the pace of data collection for the State Water Plan, except in cases that the data is already available in public sources such as DEEP diversion permit files and on the DPH web site. The time needed for DPH, CT DAS, and/or water utilities to properly determine whether a specific data set can be shared for use in the State Water Plan has been a challenge, if only because the pace of the State Water Plan development is very rapid.

Going forward, there may be other reasons for the public to have access to certain public water system data and information. For example, the State Water Plan will likely be followed by an implementation phase as well as future plan updates. Quick access to data about historical withdrawals and projected demands will make plan implementation and updates more straightforward, although some information may remain protected in the interest of public safety (including as applicable protection of public water sources and supply).

WP4-2.6. Emerging Topics

WP4-2.6.1. The Food-Energy-Water Nexus

See Section 2.2.1 for a discussion of the State Energy Strategy. The strategy calling for water conservation is well aligned with energy conservation.

Although agriculture is not a dominant water usage in Connecticut, some of the water used for irrigation in many Connecticut municipalities is derived from a service connection to the adjacent public water system. When this occurs, potable water (and often, treated water) from Class A

sources is used for irrigation. This poses a challenge for future water management for two reasons; first, it requires energy to treat the water when it may not require treatment to drinking water standards, and second, it utilizes Class A water (in some cases) that could become more scarce in the future (see previous sections in this paper).

WP4-2.6.2 Emerging Contaminants

With the prohibition on using Class B waters for public water supply, many of the state's consumers of public water supplies are relatively protected from emerging and re-emerging contaminants such as pharmaceuticals and perfluoroalkyl substances (PFASs) (compared to other states). However, when considering the thousands of septic systems in the state, some emerging contaminants may have some level of impact to water supplies. Additionally, the public water supply wellfields located along waste-receiving streams and rivers may induce some fraction of the emerging contaminants (at unknown concentrations) despite the ability of these wells to pass the testing associated with groundwater under the direct influence of surface water (GWUDI). Therefore, emerging contaminants are a valid concern in Connecticut, and a challenge going forward, while simultaneously becoming an additional reason to continue the policy of reserving Class A and AA waters for public water supply. An associated challenge to future planning is that not all drinking water in Connecticut is completely disassociated from waste-receiving streams, and future heavier reliance on water supply sources (i.e. A and AA waterways) may begin to make some sources inconsistent with the Class B prohibition.

Cyanotoxins are an emerging topic worthy of consideration for both water supplies and recreation. Climate change could play a significant role in the significance of cyanotoxins by increasing water temperatures and lowering water levels in lakes and reservoirs, making these water bodies more susceptible to cyanobacterial blooms. Other pathogen examples associated with water include Entamoeba histolytica, Naegleria fowleri, and legionella.

WP4-2.7. Aging Infrastructure

WP4-2.7.1 Coordination with WUCCs for Water Infrastructure

One of the goals of the current WUCC process is to identify areas of aging water supply infrastructure and identify pathways to address this aging infrastructure over the coming decades. This is also of interest to the State Water Plan, and the two planning processes should be coordinated in this regard (among other reasons to be coordinated).

WP4-2.7.2 Corresponding Wastewater and Stormwater Infrastructure

Like water supply and distribution infrastructure, the state's wastewater (sanitary sewer) and stormwater infrastructure is aging. Furthermore, the state has made efforts to keep up with changing water and sewer capacities by replacing pipes and pumping stations where needed, but we have not made gains keeping up with changing needs of stormwater systems. Climate change and the resulting changes in precipitation will necessitate that stormwater collection, treatment, conveyance, and discharge systems are all upgraded over time. The Connecticut Climate Change Preparedness Plan calls for upgrades to wastewater and stormwater systems to keep up with changing conditions.

WP4-2.8 Wastewater Treatment and Reclaimed Water

WP4-2.8.1 Wastewater Treatment and Effluent as Resource Recovery

Two water reclamation facilities have been established in the state. See Section 3.2.1 (Water Management Alternatives) for the description of these facilities. It is difficult to conceive of a mechanism that the average municipal water and sewer departments could fund construction of reclaimed water facilities, and even if they could, it would be challenging to identify customers for this water.

WP4-2.8.2 Stormwater Management

Individual communities must fund and comply with MS4 Stormwater requirements on their own. These requirements may be uniform from one community to another, but they may not be implemented the same from one community to the next because of the diversity in the state's municipalities. Furthermore, by their nature they are not always coordinated within river basins, where the causal mechanisms of stormwater are evident (as opposed to community boundaries). Furthermore, climate change could result in increased rainfall which could increase stormwater flows and loads even further, presenting physical challenges and financial challenges to individual communities throughout the state.

WP4-2.9. Treatment Technology

Connecticut regulations have reduced allowable nitrogen and phosphorus effluent limits that impact wastewater treatment, necessitating additional facilities and higher levels of treatment. The challenge will be to keep up technologically with interstate initiatives to restore the Long Island Sound. While the merits of improved water quality and compliance with evolving regulations are clear, the financial costs are high. Communities across the United States are faced with required expenditures on wastewater treatment that divert funds from other necessary projects. The challenge has been, and will continue to be, to ensure that technological improvements in wastewater treatment yield commensurate benefits in improved water quality in targeted receiving water bodies. Only then can the expenditures be fully justified in the face of so many other competing needs.

WP4-2.10. Extension of Sewer Systems and/or Water Systems

WP4-2.10.1 Coordination with Planning and/or Constraints from New State Conservation and Development Policies Plan

The State Conservation and Development Policies Plan (C&D Plan) is a statement of the state's growth, resource management, and public investment policies. It provides a policy and planning framework for the administrative and programmatic actions and capital and operational investment decisions of state government, which in turn influence the future growth and development of Connecticut.

The Connecticut General Assembly, in accordance with Sections 16a-24 through 16a-33 of the Connecticut General Statutes, establishes the C&D Plan. The policies of the C&D Plan are intended to guide the planning and decision-making process of state government relative to: (1) addressing human resource needs and development; (2) balancing economic growth with environmental protection and resource conservation concerns; and (3) coordinating the

functional planning activities of state agencies so as to accomplish long-term effectiveness and economies in the expenditure of public funds.

The C&D Plan consists of the plan narrative and the locational guide map (LGM). The LGM classifications are intended to help state agencies comply with administrative requirements, including that no state agency, department or institution may provide funding for a growth-related project unless such project is located in a priority funding area (PFA). Special exceptions allow for funding a growth-related project that is not located in a PFA upon determination that such project is consistent with the plan of conservation and development of the municipality in which such project is located and that such project:

1. enhances other activities targeted by state agencies, departments and institutions to a municipality within the priority funding area;
2. is located in a distressed municipality, as defined in section 32-9, targeted investment community, as defined in section 32-222, or public investment community, as defined in section 7-545;
3. supports existing neighborhoods or communities;
4. promotes the use of mass transit;
5. provides for compact, transit accessible, pedestrian-oriented mixed use development patterns and land reuse and promotes such development patterns and land reuse;
6. creates an extreme inequity, hardship or disadvantage that clearly outweighs the benefits of locating the project in a priority funding area if such project were not funded;
7. has no reasonable alternative for the project in a priority funding area in another location;
8. must be located away from other developments due to its operation or physical characteristics; or
9. is for the reuse or redevelopment of an existing site.

CGS Section 16a-31(a) requires state agencies to determine the consistency of their proposed actions with the state C&D Plan, including extension of existing sewer and/or water systems. In making this determination, the agency must first determine if a proposed project is considered a "growth-related project" pursuant to CGS Section 16a-35c(a)(2).

WP4-2.10.2 Approaches Available for Sewer Extensions for Development

Extension of sewer systems may proceed with private or local funding. If state funding will be utilized, the project must: (a) demonstrate consistency with the C&D Plan; and (b) undertake an assessment of potential adverse impacts on the environment in accordance with the Connecticut Environmental Policy Act (CEPA).

The wastewater treatment plant and service area expansion in Griswold is one example where state funding was used to extend a significant sewer system. CEPA documentation was published in the late 2000s to support the facility and sewer service area expansion, thus ending a sewer hook-up moratorium that had been imposed by the then Connecticut Department of Environmental Protection. The moratorium had been in place since 1989, severely limiting commercial and industrial development in Jewett City and portions of Griswold and Lisbon. The CEPA document included a rigorous evaluation of the State C&D Plan in effect at that time,

particularly with regard to the future service area and underlying designation in the State Plan. The plant and sewer system expansion were subsequently constructed, in part with state funding.

More recently, the Town of Mansfield undertook a similar effort in evaluating consistency of a proposed sewer extension to the Mansfield Four Corners area, located within a PFA and Balanced PFA. The Town has determined that providing public sanitary sewer service is essential for the vitality of the Four Corners area, which has a history of contamination from failing septic systems and leaking underground storage tanks. Numerous properties in the Four Corners area have had, and continue to have, chronic wastewater disposal difficulties. Additionally, development that would otherwise be consistent with local, regional, and state land use plans has not been realized in the Four Corners area due to a combination of poor soil conditions, high groundwater, lot size, and site constraint factors. A CEPA Environmental Impact Evaluation was published in January 2016 to support $3M in funding through DEEP. The EIE and Record of Decision are currently under review by OPM.

In other communities, Ledyard Center being just one, state funding of a sewer extension has been thwarted in the past by virtue of inconsistency with the State C&D Plan. Ledyard's municipal Plan of Conservation and Development (last updated in 2003) recognizes that sewer capacity in Ledyard is a limited resource and that many developable areas remaining in Ledyard are characterized by shallow depth to bedrock, steep slopes, a high groundwater table, and/or the presence of wetlands. Ledyard's Plan identifies as a strategy for provision of sewer and water infrastructure to commercial and industrially zoned areas such as along Route 12 and Ledyard Center to facilitate the growth of commercial development. The prior State C&D Plan (2004 – 2009) designated Ledyard Center as a Rural Community Center; thus extension of public sewer service to this area was deemed to be inconsistent with the C&D Plan and ineligible for state funding. The current C&D Plan designates this area as a Village Priority Funding Area, which could potentially proceed with state funding of public sewer service if the sponsoring state agency can document that the extension will help sustain village character.

WP4-2.10.3 Approaches Available for Sewer Extensions Beneficial to Water Quality

In some instances, existing development has occurred in areas that do not support on-site wastewater disposal systems, often as a result of poor soil conditions, a high water table, or small lot sizes. Failing or underperforming septic systems have the potential to impact adjacent wetlands and watercourses, cause contamination of drinking water supply wells, and/or create a condition that is harmful to public health. In such instances, sewer extensions can significantly benefit water quality and improve public health conditions.

In summary, the primary challenges associated with sewer system expansion in Connecticut are inconsistency with state, regional, and local plans; local opposition due to perceived induced development; inability to secure state funding when the action is contrary to the C&D Plan to the point that the inconsistency cannot be resolved; and lack of funding in general.

Section 4

Stakeholder Participation and Outreach

4.1 Consensus-Based Approach

The Plan is based on the consensus directives and decisions of the stakeholders, who, in addition to representing their organizations and interests in various water sectors, will also receive and apply input from the public. This is important – it distinguishes the Plan from a consultant's recommendations, and presents recommendations directly from Connecticut's stakeholders. Once approved, the plan will become a Water Planning Council document.

The Other States' Plans workgroup investigated the consensus based approach, which they documented under water planning principals 3, 4, and 5, as represented below:

Water Planning Principle 3: Public and Stakeholder Process

A strong commitment to public process is critical to successful state water planning. Everyone uses water, and as a result, everyone has a role to play in water planning. Public outreach and public and stakeholder engagement together with on-going access to transparent, high quality information and communication contributes to a process that is perceived as legitimate. Ultimately, creating a legitimate planning process is fundamental to the successful adoption and implementation of a state water plan.

The state water planning process should include engaging stakeholders and the public to allow the plan to be shaped and informed by the expertise and needs of the community and to allow everyone to be informed of potential changes that may affect their interests. Public and stakeholder engagement processes can also help to minimize conflicts or provide space for resolving conflicts when they arise.

PA 14-163 mandates that the Water Planning Council seek the involvement of interested parties and solicit input from the Advisory Group when developing a state water plan and further specifies a detailed process and timeframe for public review and comment prior to plan finalization. The Act does not appear to require ongoing involvement of the public through implementation. Outreach and engagement are especially important as the planning process becomes more local; a locally focused engagement process should be defined as the plan is developed.

Water Planning Principle 4: Integrated Approach

To account for the complexities of the human-hydrologic-ecologic water system, PA 14-163 directs the Water Planning Council to consider a range of factors including identifying quantities and quality of surface and groundwater for public water supply, health, economic, recreation, and environmental benefits while taking into account desired ecological, recreational, agricultural, industrial, and commercial use. Moreover, the Act links land use and development to water quality and quantity. Although the Act does not specifically mandate integration of these factors, our review of other states suggests that integration is essential to an effective state water plan.

Water Planning Principle 5: Fair and Equitable Process for Balancing Values

Because water is a finite, non-substitutable resource an effective state water plan should include a process to facilitate a fair and equitable process for balancing values and resolving conflicts. This is particularly important for basins that may be or may become over-allocated, and where, during a drought or other water-supply emergency, there simply is not enough water to meet the in-stream and out-of-stream demands. Consistent with this principle, PA 14-163 includes a provision that the state water plan recommend the utilization of the state's water resources, including surface and subsurface water, in a manner that balances public water supply, economic development, recreation and ecological health. Further, the Act requires that the WPC, in developing the state water plan, examine appropriate mechanisms for resolving conflicts related to implementation of the plan.

Our review of other states water planning processes suggests that most states recognize the need to balance competing water uses and provide mechanisms for negotiating values among different uses within the planning process. For example, states that specify broad stakeholder representation on state and regional/local advisory groups (inclusive of different water users including environmental groups) provide opportunities for resolving conflicts between uses and for negotiating different competing values. There are challenges inherent in achieving a fair and equitable balance of values in practice. It is possible not everyone involved will have the same influence on the outcome.

Connecticut must be vigilant in creating processes that enable the full range of interests to be represented in the planning process and to ensure that no one group dominates the process. This will ensure that the outcome reflects a shared vision at appropriate resource planning scales.

4.2 Identification of Stakeholders

The Water Planning Council Steering Committee (WPCSC) members were selected based on various groups of water users that comprise the plan's stakeholders. The WPCSC consists of the four WPC members, plus 15 individuals in leadership roles with subject matter expertise. These members represent a broad range of perspectives, including public water supply companies, environmental protection groups, regulators, industry water users, wastewater treatment providers, and others. The list of Steering Committee members and their affiliation is shown in **Table 4-1** below.

Table 4-1. List of Steering Committee Members and Their Affiliation

Steering Committee Member	Affiliation
Elizabeth Barton	Day Pitney
John W. Betkoski III	WPC Member, PURA
Larry Bingaman	South Central Connecticut Regional Water Authority
Chris Clark	Mohegan Tribe
Virginia de Lima	Science & Technical Subcommittee Chair, USGS-scientist emerita
Samuel Gold	Lower CT River Valley COG
Bart Halloran	Metropolitan District Commission
Elin Swanson Katz	Office of Consumer Counsel
David LeVasseur	WPC Member, OPM
Gene E. Likens	Cary Institute of Ecosystem Studies
Andrew Lord	Lord Law LLC and Connecticut Association of Water Pollution Control Authorities
Lori Mathieu	WPC Member, DPH
Joseph McGee	The Business Council of Fairfield County
Margaret Miner	WPC Advisory Group Co-chair, Rivers Alliance of CT
Robert Moore	Policy Subcommittee Chair
Susan Stratton Sayre	Smith College, Department of Economics
Michael Sullivan	WPC Member, DEEP (Note: Michael Sullivan retired from DEEP in February 2017)
David Sutherland	The Nature Conservancy
Maureen Westbrook	WPC Advisory Group Co-chair, Connecticut Water Company
Betsey Wingfield	WPC Member, DEEP (Note: Replaced Michael Sullivan as DEEP WPC representative following his retirement)
Julie Zimmerman	Yale University, Environmental Engineering

4.3 Results of Stakeholder Workshops

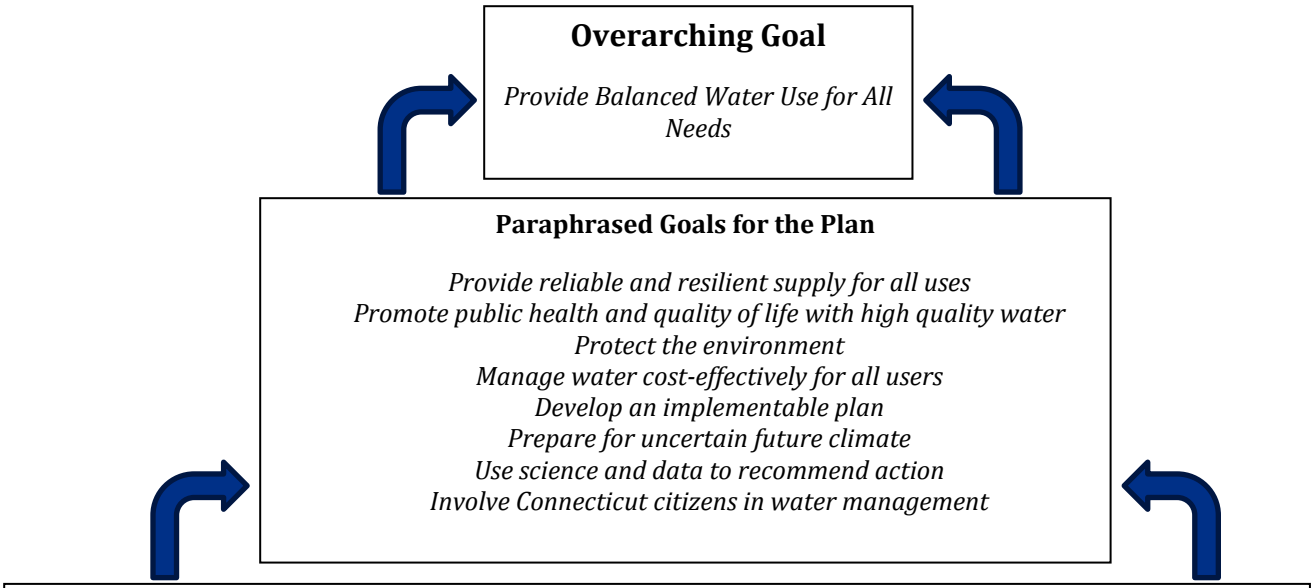
Six workshops were held during the development process for the State Water Plan, as illustrated in **Figure 4-1** below:



Figure 4-1. Planned Workshops to Support Plan Development

Since Phase I was dominated by information gathering and establishing the planning framework for the Plan (objectives, options, challenges, etc.), only one workshop was held during Phase I. Five subsequent Workshops 2 through 6 were held in Phase II, all five of which focused on making decisions using the information gathered in Phase I.

The first of six workshops was held on September 29, 2016. Its stated goal was to achieve consensus on the Plan objectives, and the future water management options that require some form of address in the Plan (either policy recommendations, pathways forward for future years, or opportunities to collaborate further). The workshop was professionally facilitated, and after separating the 17 issues from the state statute into goals for the plan and options to achieve these goals (refer to Section 1.4.2), consensus was achieved on how to articulate these goals and future options, both with the specificity required by the statute, and paraphrased into key "soundbites" that may be useful in sharing the framework of the plan with the citizens of Connecticut. The wording of these was refined during Workshop 2. The consensus-based goals are illustrated in **Figure 4-2**, and the options that the stakeholders agreed to evaluate in the Plan are listed in **Table 4-2**.



Full List of Goals Based on Public Act 14-163

OBJECTIVES OF THE PLAN

- *Provide resilient water supply and water quality for ALL current and future water needs using available surface and groundwater while maintaining an adequate margin of safety for Public Water Supplies:*
  - *Recreational, Ecological, Drinking water supply (public and private), Agricultural, Industrial / Energy, Commercial, Wastewater Discharge, Economic Development*
- *Define and address impacts to ecology, environment, public health and safety, economic health, community health, and overall quality of life.*
- *Develop water management strategies that are resilient to future uncertainty in climate, regulations, and economic conditions.*
- *Educate citizens on water management programs, policies, and opportunities to participate.*
- *Manage the cost and security of water supply, treatment, stormwater, and wastewater systems.*

OBJECTIVES FOR DEVELOPING THE PLAN

- *Make progress on each identified water management option and challenge by drafting a recommended policy/strategy, or formulating a path forward with information needs, decision processes, and methods of conflict resolution.*
- *Develop an implementable Plan with achievable near-term and long-term goals, reliable funding mechanisms for ongoing planning and infrastructure, and an effective management structure for making decisions on future water uses.*
- *Produce a plan that is scientifically based and data driven, including costs and benefits of alternatives, while understanding the information gaps.*
- *Coordinate with other state and local plans*

Figure 4-2. Consensus-Based Goals of the State Water Plan

Table 4-2. Future Water Management Options to Help Achieve the Plan's Goals*

Category	Options
Policy and Planning Options	Land use practices and protection
	Water conservation, incentives, rate structures
	Incorporation of existing local and state plans, such as water supply, energy, land conservation, etc.
	Regionalization of water supply and appropriate interconnections
	Identify funding mechanisms for Plan implementation and updates
	Develop monitoring plan for Plan implementation
	Statewide drought planning and mechanisms to enforce water restrictions
	Future Class B water for non-potable uses
	Water use accounting
	GW and private well monitoring and protection
Technology Options	Technology and facility improvements/replacement
	Water Reuse and Greywater use
	Wastewater management
	Stormwater management
	Desalination
	Flood management
	Leak detection
	Real-time flow monitoring
Regulatory Options	Address registered diversions
	Implement instream flow regulations
	Changes to laws / regulations
Outreach Options	Public Education – Short and Long Term

* The Plan will address each option in one of several ways: It will either provide policy recommendations, outline a pathway forward for future years (including methods for decision making and conflict resolution), identify opportunities for further collaboration, or acknowledge that the option is being addressed by other initiatives, programs, or legislation.

As the Plan progressed into Phase II, these options were evaluated for their ability to help achieve the goals of the Plan. The workshops held in Phase II are summarized, along with their overall goals, as follows:

- Workshop 2 held November 17, 2016: Refinement of water management options and challenges, and to categorize the identified water management options and future challenges into three categories: (1) consensus is likely, and draft language for recommendations can be prepared, (2) consensus is not likely before May 2017, and the Plan will recommend paths forward for future progress, and (3) the option or challenge is either acknowledged as unchangeable or as being addressed by separate initiative(s).

- Workshop 3 held January 12, 2017: Review those options and challenges where consensus is likely, and accumulate ideas and important concepts associated with each of the policy recommendations.
- Workshop 4 held February 2, 2017: Review a draft framework for the Water Planning Council during implementation, including management structure, future decisions, conflict resolution. Identify top priorities for options and challenges, and initiate components of pathways forward for those water management options and challenges that cannot achieve consensus by May 2017.
- Workshop 5 held February 16, 2017: Review the draft policy recommendations, including support and presentation by members of the Policy Subcommittee, who presented the policy recommendation to the WPC and Steering Committee.
- Workshop 6 held April 20, 2017: Report efforts completed on the policy recommendations, the pathways forward, technical information (including regional basin data sheets and maps), and comparison of work to date with the statutory requirements for Plan development.

The Phase II workshops efforts and findings were used to develop the Plan recommendations, including policy recommendations, pathways forward, WPC management structure. Sections 5 and 6 of the Plan reflect the Phase II workshops efforts, along with additional input from the WPC and subcommittees.

4.4 Themes from the Public Meetings

There were three public meetings held in Phase I, which included a summary of the plan components and work completed to date, a public comment and response period, and then a summary of upcoming work in Phase II. These meetings were held in late October 2016, and were purposely located at various regions throughout the state as follows: Norwich in the eastern part of the state, New Britain in the central part of the state, and Southbury in the western part of the state.

The themes of public comments at each of the meetings are summarized as follows:

- Eastern public meeting: Public water suppliers stressed the importance of data-based decisions, cost, and implementation ability. Individual homeowners asked about whether and how their water rights would change. Individual privately-held water supply was discussed regarding the ability to sell. Past concerns related to stormwater runoff and development were discussed as continued applicability. Shore ecological health including shellfish were also discussed.
- Central public meeting: Public water suppliers noted their support of the plan, again stressing the importance of data-based decisions, along with the importance of registration protection and affordable water rates. Individual homeowner wells and drillers asked how this plan affects them. Other comments included the need to prioritize stressed areas, to consider climate change and future conditions, that there be adequate funding, and to make sure the process is transparent with many opportunities for public involvement.

- Western public meeting: Individual water wells, including drawdown responses and lake communities were discussed, along with the quality and quantity of individual wells, including construction practices. Landscaping practices were discussed related to water use and how there are alternative landscaping practices that promote low water use. Public water supplies discussed examples of how adjacent communities may need to work together to serve the needs, and overall consumer cost of water was noted.

Phase II also included three public meetings, however in Phase II, the public meetings were scheduled according to progress of various components of the Plan. Each of the Phase II meetings were approximately 2 hours long, with the first half hour summarizing work to date, an hour for public comment, and then followed by the last half hour of upcoming work and next steps. Phase II public meetings were held as follows:

- Public meeting # 4 was held January 26, 2017 at the South Central Regional Council of Governments (SCRCOG) offices in Norwich. This meeting summarized work to date, including regional basin maps and data sheets, along with the report of expected water management options and challenges.
- Public meeting # 5 was held February 23, 2017 at the Southbury Town Hall. Similar to the public meeting #5, work to date was summarized.
- Public meeting # 6 was held May 16, 2017 at the Legislative Office Building in Hartford. This meeting included a summary of the Plan development, and was located to encourage legislators attendance so that approval and implementation of the Plan can be supported.

4.5 State Water Plan Fact Sheet

The plan fact sheet was developed in Phase I to summarize the goals and scope of the Plan, and was updated during Phase I to reflect known dates of workshops and public meetings. The fact sheet is a single paper document, double-sided, which has been shared at various plan workshops and meetings. It is meant as an overview of the plan and project, and gives information on opportunities for public participation in the process.

The October 2016 version of the fact sheet is included as Appendix A to this report.

4.6 Continuing Opportunities for Stakeholder and Public Involvement

4.6.1 Document Availability and Submitting Written Comments prior to and during Plan Development

During Plan development, the WPC made documents available for public review via their website and collected comments to the Plan and any of the documents using the docket for the WPC. Docket No. 14-08-09 contains almost 600 comments catalogued through November 2016 (including a letter with over 1,000 signatures), received by the WPC and considered during development of the Plan. This significant response reaffirmed the importance of stakeholder involvement throughout Plan development. [Docket available at http://www.dpuc.state.ct.us/dockcurr.nsf/(Web+Main+View/All+Dockets)?OpenView&StartKey=14-08-09]

4.6.2 Document Availability, Public Outreach and Submitting Written Comments to the June 2017 Final Draft Report of the State Water Plan

The WPC used the June 2017 final draft version of the State Water Plan to present to various groups and sessions around the State of Connecticut in preparation for delivery to the legislators in January 2018, as required by statute. An online comment collection method was created to collect public comments submitted following this June 2017 Final Draft Report. Comments were received through November 20, 2017, and the WPC reviewed, discussed and incorporated changes to the Plan corresponding to the comment review period. Note that there is a comment response memorandum and log of all comments received with brief responses available on the WPC website. This section details public outreach activities by the WPC between the June 2017 final draft version of the State Water Plan and this final report dated January 2018.

The Water Planning Council (WPC) established the State Water Plan (the Plan) Outreach Team in July 2017, to conduct and coordinate activities and events promoting the awareness and public review of the draft Plan and opportunities for residents to provide public comment on the plan. The Outreach Team, led by WPC member Lori Mathieu, convened weekly either via conference call or in person between July and November 2017. Representatives from each WPC member agency made up the Team, specifically: (DPH) Linda Ferraro, Maura Downes, Christopher Stan, Elizabeth Conklin; (DEEP) Corinne Fitting, Dennis Schain, Melissa Czarnowski, Naomi Davidson; (PURA) Gail Lucchina, Nicholas Neeley; (OPM) Eric Lindquist, Chris McClure.

The primary goal of the Outreach Team was to reach a broad audience and engage them in the Plan. Efforts focused on communicating policy recommendations and next steps or "pathways forward" identified in the Plan, as well as continuing dialogue on achieving the overarching goal of the Plan. As a result of the Team's efforts, the members of the WPC presented to and participated in thirty-six events, with audiences including: CT Business and Industry Association, CT American Association of Retired Persons (AARP), Department of Public Health's (DPH) Strategic Planning Committee, State Health Improvement Plan Advisory Council, Local Health Departments, Fisheries Advisory Council, Council on Environmental Quality, National Ground Water Protection Council, CT Conference on Municipalities, CT Assoc. of Golf Superintendents, City of Bridgeport/Health Director hosted "Water Forum", Yale School of Public Health, and CT Irrigation Contractors Association. The members of all the state's Council of Governments (COGs) heard presentations and were provided information about the Plan, as the WPC recognized the COGs members as key stakeholders in the Plan and essential decision makers in its future implementation.

Public Meetings

Outreach efforts included three regional public information meetings, hosted by legislators that were key in developing and moving forward legislation requiring a state water plan. These meetings were held during the evening to ensure the public's participation and included a brief presentation on the Plan from the WPC members. The information meetings were specifically designed to afford a question and answer session with the WPC members and the public. Meetings were hosted by Representative John Hampton in Simsbury; Representative Mary Mushinsky in Wallingford, with Senator Ted Kennedy in attendance; and Representative Jonathan Steinberg in Westport. These sessions, all well attended, provided a unique opportunity for a

conversation between the audience and WPC members and enhanced the awareness of water related issues from a broad spectrum of stakeholders.

Public Hearing

As required by statute, a formal public hearing was held on October 30, 2017 in Hartford. It was well-attended, with thirty-eight members of the public providing comments. A transcript of the meeting was prepared and is available online (www.ct.gov/water), along with a video-tape of the meeting.

WPC Website

In addition to the public meetings, information on the Plan and the planning process was made readily available through the WPC website at www.ct.gov/water. The website served as the main link for information and resources for the WPC Plan outreach and documents.

Webinar

The Outreach Team produced a webinar, with all WPC members presenting on the Plan. The webinar was posted to the WPC website and could be accessed on-demand. A slide presentation developed by the Outreach Team was also posted to the WPC website. This presentation was used by the WPC members during their appearances at venues, and could be used by stakeholders to promote the Plan.

Social Media

The WPC agencies posted announcements and links about the Plan on their respective agency websites and utilized agency Facebook and Twitter accounts to distribute information and notifications about the Plan.

Press

The Outreach Team developed and issued two press releases and multiple press alerts between July and November 2017. An initial press release announced the availability of the draft Plan for public review and public comment period. A subsequent press release and press alerts notified media outlets of the multiple regional information meetings and public hearing. The Team utilized existing agencies' email distribution lists as well as the WPC email alert list to encourage additional circulation of the press releases.

A variety of state and local media outlets produced stories covering the Plan and members of the WPC took part in radio and television interviews with broadcasters such as National Public Radio (WNPR) and Comcast Newsmakers.

Public Comments

The 120-day public comment period was open from July 20, 2017 to November 20, 2017.

In order to facilitate an efficient transmittal and compilation of written comments on the draft plan, the Outreach Team developed an online survey instrument through the Survey Monkey website to automatically collect and catalog comment submissions. The survey allowed for comments to be submitted in a plain text dialog box, or to be uploaded as a Microsoft Word or PDF document.

The majority of comments were submitted using the online survey, although some were transmitted via email. In total, 184 unique written comments were received from 273 separate individuals, the private sector and organizations. The written comments were assembled in a spreadsheet that was made available on the WPC website and updated on a weekly basis throughout the public comment period. A final spreadsheet of all written comments is available on the WPC website for public review. Oral comments received during the formal public hearing are contained within the transcript of that hearing, a copy of which is also available on the WPC website. A report on the summary of the comments, including a complete log of comments and responses is available on the WPC website. Table 4.3 includes a list of public outreach efforts by the WPC between July and November 2017, in chronological order.

Table 4.3. List of Public Outreach Activities between July - November 2017

Date	Event
JUNE	
6/28/2017	Lower CT River Valley Council of Government (COG)
JULY	
7/11/2017	Western Water Utility Coordinating Committee (WUCC)
7/12/2017	Eastern WUCC
7/19/2017	Central WUCC
7/20/2017	Department of Public Health (DPH) Strategic Planning Committee
7/20/2017	DPH Local Health Dept. monthly conference call
AUGUST	
8/17/2017	DPH Local Health Dept. monthly conference call
8/18/2017	American Association of Retired Persons - AARP-CT
8/23/2017	Southeastern COG
SEPTEMBER	
9/8/2017	State Water Plan- WEBINAR- taping
9/13/2017	Rep. John Hampton - Public Informational Meeting
9/14/2017	N.W. Hills COG
9/14/2017	Fisheries Advisory Council of DEEP
9/20/2017	Council on Environmental Quality
9/21/2017	DPH Local Health Dept. monthly conference call
9/25/2017	Bridgeport Public Water Forum - Plan overview
9/26/2017	DPH State Health Improvement Plan - Advisory Committee
OCTOBER	
10/3/2017	Connecticut Conference of Municipalities (CCM) - Legislative Committee
10/3/2017	Water Planning Council
10/3/2017	Naugatuck Valley COG Regional Planning Commission
10/5/2017	Western COG
10/5/2017	River's Alliance Conference
10/10/2017	CT Association of Golf Course Superintendents (CAGCS)
10/18/2017	CT Business and Industry Association, Environmental Policy Council
10/18/2017	Capitol Region COG
10/19/2017	DPH Local Health Dept. monthly conference call
10/24/2017	CT Water Works Assoc. Fall Conference
10/25/2017	Lower CT River Valley COG
10/25/2017	S. Central Reg. COG
10/26/2017	Public Meeting - Rep. Jonathan Steinberg
10/30/2017	CT Public Health Association. Annual Meeting
10/30/2017	Public Hearing - Hartford DEEP
10/31/2017	Yale School of Public Health
NOVEMBER	
11/7/2017	DPH -Commissioners Semi-Annual Conference for Health Directors
11/8/2017	Public Meeting - Rep. Mary Mushinsky
11/15/2017	Connecticut Irrigation Contractors Association
11/17/2017	Naugatuck Valley COG

Section 5
Plan Recommendations

As part of Phase II efforts, water management options were evaluated for their ability to help achieve the goals of the Plan in the context of the Basin Stress Indicators defined in Section 2. That is, the recommendations are based on established needs for future water management – the Plan does not recommend action where it cannot be directly linked to established needs and the goals of the Plan.

5.1 Future Water Data Needs

The following suggestions are offered following a comprehensive data collection program during Phase I of the Plan development process. These suggestions are offered so that decisions can be more informed, future planning can be simpler and more complete, and uncertainty around water needs and availability can be reduced. These suggestions are offered for discussion and consideration, and should not be construed as mandates since there may be costs associated with some forms of data collection and organization.

- Standardize the annual reporting for permitted diversion withdrawals and make the reporting program electronic rather than paper-based.
  - Reporting templates should include universally applicable questions as well as questions that are specific to the water use or type of source.
  - Reporting templates should allow distinction between fresh water (new water) and recycled water for those facilities that recycle such as agriculture/nurseries and the sand and gravel extraction/washing industries. Without this distinction, resource allocation planning is difficult.
- Meter and record daily or monthly withdrawals at each source used by registered water users. Annually report withdrawal data to DEEP, similar to the reporting conducting by diversion permit holders, and using an electronic format for reporting after it is implemented as recommended above. Connecticut Public Act PA-04-185 provides guidance.
- Proceed with legislation that allows certain parts of Individual Water Supply Plans to be made available for public review and water management planning, and streamline the Freedom of Information process so that this information can become more readily available.
- Meter and record daily transfers of water between reservoirs within reservoir systems. Allowable methods of metering may include installed flow meters, weirs, gaging stations, etc. Annually report transfers to DEEP and DPH.
- Ensure that metering and recording of daily withdrawals at each source in small Community Water Systems (systems serving fewer than 1,000 people that are not subject to development of Individual Water Supply Plans) is occurring and annually report data to DPH and/or DEEP (depending on whether a diversion permit is in place).

- Meter and record weekly or monthly withdrawals at each source in small Non-Transient Non-Community Water Systems. Annually report data to DPH electronically.
- Meter and record weekly or monthly withdrawals at each source in small Transient Non-Community Water Systems. Annually report data to DPH electronically.
- Establish a database of all groundwater wells in the state, public and private.
- Implement a water quality testing and reporting program for private wells with automatic reporting to DPH and local health districts. Connecticut General Statutes Section 19a-37, subsection (b) requires submittal of water quality test results to DPH and the local health department when testing is done for a real estate transaction, but it may be valuable to consider more frequent/periodic testing.
- Ideally, it would be useful to implement a water volume monitoring or reporting program for private wells, but this may be impractical. One way to improve private well data would be to establish laws or regulations that require information on the capacity of the pump installed in the water supply well be reported and maintained in the statewide database for all water supply wells (both existing and future). The database would have all the same information about a water supply well that is currently provided on the paper well completion reports filed by a well drilling contractor, and would represent an upper limit on total private well capacity in the state. It would be important to recognize that capacity is usually a poor indicator of actual usage, because private wells are typically not pumping continuously, but it would be a step toward better centralized data on total private well capacity in the state.
- Maintain state partnership programs with the USGS for flow and groundwater monitoring, and encourage augmenting existing monitoring networks as funding allows.

5.2 Recommended Water Management Policies

5.2.1 Introduction

This section contains all the policy recommendations that have resulted from the year-long process of deliberation and consensus building. This is a consensus-based plan, and the policy recommendations in Section 5.2 represent consensus-based decisions; the topics were identified by stakeholders (via the Steering Committee) as those for which common ground could be identified across all water sectors, and the language was developed collaboratively by stakeholders serving on the Policy Subcommittee.

Tables 5-1 and 5-2 categorize all the water management options and challenges identified by the WPC Policy Subcommittee and Steering Committee during Phase II workshops into three groups (and that categorization is represented using yellow highlighting in the subject tables):

- Consensus Likely
- Needs a Decision Process or Pathway Forward (more information, additional outreach, etc.) – See Section 5.3 for detailed discussion and recommendations
- Acknowledge or Address Elsewhere (for example, new regulations already enacted, or planning processes addressed by separate plans and processes).

Table 5-3 consolidates the water management options and challenges for which the WPC Policy Subcommittee and Steering Committee felt that consensus could be reached, and for which subsequently the policy recommendations were drafted (in Section 5.2.3). Areas of acknowledgement were considered to be consensus-based, and recommendations were drafted to reinforce current policy in the Plan. Note that some issues were identified as ripe for consensus *and* needing additional information or outreach to advance toward fuller understanding or consensus. The portions of these issues for which consensus was achievable are addressed with recommendations in this Section (5.2), while the portions that required additional information or outreach are discussed in Section 5.3 (Pathways Forward). Hence, some issues are included in both sections.

The options and challenges addressed in this section are policy recommendations, which means that they are neither law nor regulation. Instead, they are intended to become guiding principles that help form the basis of informed and focused water management guidelines, laws, and regulations for the future of Connecticut.

Section 5.2.2 lists the most important policy recommendations, excerpts from the broader and more comprehensive lists of recommendations in Section 5.2.3. That is, the "Top 11" recommendations in Section 5.2.2 have been culled from the policy papers in Section 5.2.3 as the highest priority policies to guide future water management. Section 5.2.3 includes the more detailed policy recommendations, as drafted and agreed upon by the WPC Policy Subcommittee in response to the Steering Committee workshops.

Table 5-1. Stakeholder Majority Opinions for Likely Areas of Consensus on Water Management Options (as Voted in Workshop #3)

Type of Issue Required in the Plan		List of OPTIONS	Consensus Likely	Need Decision Process / Path Forward	Acknowledge or Address Elsewhere
Water Mgt. Options	Policy and Planning	Land use practices and protection			
		Conservation and incentives			
		Incorporation of existing plans			
		Regionalization and appropriate interconnections			
		Identify funding mechanisms for Plan implementation			
		Develop monitoring plan for Plan implementation			
		Statewide drought planning			
		Future Class B water for non-potable uses			
		Water use accounting			
		GW and private well monitoring and protection			
	Technology	Technology and facility improvements/replacement			
		Water Reuse and Greywater use			
		Wastewater management			
		Stormwater management			
		Desalination			
		Flood management			
		Agricultural Policies			
	Regulatory	Address registered diversions			
		Implement instream flow regulations			
		Changes to laws / regulations			
	Outreach	Public education – short and long term			

Table 5-2. Stakeholder Majority Opinions for Likely Areas of Consensus on Water Management Challenges (as Voted at Workshop #3)

Type of Issue Required in the Plan		List of Challenges	Consensus Likely	Need Decision Process / Path Forward	Acknowledge or Address Elsewhere
Challenges	Inherent in the CT Regulatory/ Govt. Structure	Home rule			
		Levels of authority for implementation			
		Continued Prohibition of Class B water for human consumption			
		Public perception / uncertainty			
		Funding			
		Data Gaps			
		Understanding Economic Impacts			
	Specific to Certain Water Uses	Registered diversions (see Options)			
		Unreported uses			
		Adopting instream flow practices			
		Coordination with WUCC			
		Watershed/aquifer protection where incentives are lacking			
		Vulnerability and security issues			
		Food-Energy-Water Nexus			
		Emerging contaminants			
		Aging infrastructure			
		Constraints on system expansion			
		Climate Change			
		Water Quality Impairments			

Table 5-3. Consolidated List of Areas with Likely Consensus, as Voted by Stakeholders

Type of Issue Required in the Plan		List of OPTIONS	Consensus Likely	Need Decision Process / Path Forward	Acknowledge or Address Elsewhere
Water Mgt. Options	Policy and Planning	Land use practices and protection			
		Conservation and incentives			
		Incorporation of existing plans			
		Develop monitoring plan for Plan implementation			
	Technology	Agricultural Policies			
	Regulatory	Address registered diversions			
		Implement instream flow regulations			
	Outreach	Public education – short and long term			
Challenges	Inherent in the CT Regulatory/ Govt. Structure	Home rule			
		Continued Prohibition of Class B water for human consumption			
		Funding			
		Data Gaps			
	Specific to Certain Water Uses	Coordination with WUCCs			

5.2.2 Consensus-Based Policy Recommendations

The following list identifies the most important policy recommendations from this Plan, by consensus of the Policy Subcommittee. These are not in hierarchical order, but in aggregate represent consensus-based issues to be elevated to the decision processes of the regulatory agencies and Connecticut Legislature. These recommendations are also included in the broader lists of recommendations in Section 5.2.3, but are **paraphrased** here for simplicity and ease of conveyance to others.

1. **Science Basis:** Ensure that water management activities follow scientific examples and make scientific sense.
2. **Obsolete Diversion Registrations:** The state should consider a means of identifying whether a diversion registration is obsolete`, and if so, removing it from the record.
3. **Innovative Agricultural Practices:** The state should encourage innovation in agriculture that promotes water reuse, improved and expanded storage, and water quality trading (watershed based trading between point and non-point sources) to address non-point source pollution.
4. **Centralized Data:** Water data (or access to it) necessary for Plan implementation should be centralized to enhance the efficiency of future planning and Plan updates. The state should establish a single database and/or portal that will serve as a repository and link for ongoing and future water and environmental monitoring data. The database could include links to outside organization information (such as USGS, NCDC, and State Agency databases).
5. **Class B Water for Non-Potable Use:** Current and future non-potable uses of water should be reviewed by individual users (with input from utilities and state agencies and coordination with the Siting Council when applicable) to determine if Class B water could be an environmentally prudent and cost-effective alternative to Class A/AA water. See also #6 below. The WPC should provide guidelines for review of Class B water for non-potable uses such that individual users and utilities can evaluate opportunities on a consistent basis even though individual economic or environmental circumstances may prevail. A "Triple Bottom Line" approach that considers economic, environmental, and social factors may be an appropriate framework.
6. **Water Conservation:** The state should develop an education and outreach strategy that includes water conservation topics. This work could include surveys of public attitudes, and partnerships with water providers and other water educators, and should include a focus on educating youth through schools, scout programs, etc. The state should also work with stakeholders to explore means of reducing outdoor water use.
7. **Consistency with Other Plans:** The WPC should provide ongoing review of other state plans (such as C&D, WUCC Plans, Blue Plan, etc.) such that any potential inconsistencies with the Plan can be identified. The WPC should also share relevant information from the Plan to inform and ensure consistency with updates to other state plans as they pertain to water management. The WPC can recommend how inconsistencies could be addressed on a case-by-case basis.
8. **Regionalization:** Where regional solutions are practical and beneficial, the state should encourage such activities as inter-municipal negotiations on water sharing (either on an emergency or permanent basis), municipal cooperation when identifying land for open space and recreational use, system consolidation, and the involvement of the regional Councils of Government. The state should also consider removing the underlying barriers.

9. **Land Use Protection:** Reaffirm support for the protection of Class I and Class II lands (property protected for water supply). Encourage the acquisition or protection of additional watershed lands (including land that affects groundwater quality) and strive for consistency with recommendations of the State's Green Plan. Also, where possible, attempt to avoid new sewer, gas, and oil lines through Public Water supply watershed areas unless such passage solves other prevailing water quality problems.
10. **Public Education and Outreach:** The state should create a data-based water education to reach key constituencies that may not be active in the Plan development process, such as: The general public, municipal government officials, and state legislators.

5.2.3 Summary of All Policy Recommendations

The following sections represent the complete consensus-based recommendations on future water policy for the State of Connecticut. These recommendations should serve as guiding principles for the following:

- Future water legislation
- Future regulations on water allocation and management
- Future decisions on specific water projects
- Future activities to help keep Connecticut's water planning process thorough, consistent, and data-driven

These recommendations were drafted, reviewed, revised, and agreed upon by the WPC Policy Subcommittee under the guidance of the Plan's consultants. They were all drafted in response to stakeholder directives from the series of workshops conducted during the one-year planning process. They are listed in no particular order of priority or importance, and include the following:

- Land Use Practices and Protection Related to Water
- Water Quality and Quantity Management
- Water Conservation
- Consistency with Existing State Plans
- Monitoring for Plan Implementation
- Agricultural Practices
- Unused Registered Water Diversions
- Implementation of Minimum Stream Flow Regulations
- Outreach, Education and Public Engagement
- Regionalization
- Class B Water for Non-Potable Use
- Data Accessibility and Accuracy
- Coordination with Water Utility Coordinating Committees (WUCCs)

5.2.3.1 Land Use Practices and Protection Related to Water

Purpose: Land-use planning and water planning can become more closely connected through the integration of several principles. Integration does not mean dilution of local control. Connecting these planning disciplines will not diminish private property rights, and local zoning and development control. Financial incentives, best practices, partnerships, and technical resources can potentially better coordinate and enhance land-use planning and water planning for quantity and quality. While density will be a major factor in reducing domestic water demand, it is but one facet of creating more water-sensitive land-use decisions.

Notes: This language evolved from discussions at stakeholder workshops during the Plan development process, meetings of the WPC Policy Subcommittee, and CDM Smith examples from other states that have included land use practices as part of state planning recommendations.

Suggested Policy Recommendations:

A future goal for Connecticut can be that communities incorporate water-saving actions into land-use planning. To facilitate the use of local land-use tools to reduce water demands for municipalities and urbanization on to open or agricultural lands, the state or WPC could work with partners to pursue the following actions.

1. **Public Water Supply Lands:** Reaffirm support for the protection of Class I and Class II lands, as well as watershed property protected for water supply. Encourage the acquisition or protection of additional watershed lands including lands contributing to the protection of groundwater quality. Continue to carefully manage water company owned lands, which have additional protections established by state statute. Strive for consistency with the recommendations of the State's Green Plan. Where possible, avoid the construction of new sewer, gas and oil pipelines through public water supply watersheds except to solve or prevent a water quality problem.
2. **State Conservation and Development (C&D) Plan:** Review the State C&D Plan to ensure that the initiatives and recommendations of each are synchronized and/or complementary. The previous C&D Plan included some policy statements and objectives related to watershed protection that were not specifically listed in the current version of the C&D Plan. The Plan should revisit some of these principles and recommend that they be considered for inclusion in the next edition of the C&D Plan, or be explicitly stated in the State Water Plan.
3. **Low-Impact Development:** In coordination with recommended Public Outreach programs, help educate Connecticut citizens about the benefits of Low-Impact Development using LID tools and practices already available.
4. **Groundwater Protection:** The state should promote groundwater protection through land management programs such that groundwater classifications of GA and GAA can be more widely understood and maintained. The state should also develop and extend groundwater protection best practices to protect private wells. The following are noted:
    - Aquifer Protection Program – The existing Aquifer Protection Program should continue to provide protection for public water supply wells developed in overburden deposits that are utilized by CWSs serving more than 1,000 people. It is possible that some elements of this program may be reviewed for use in other groundwater protection programs.

- Groundwater Protection – The State's Water Quality Standards should continue to provide protection of groundwater – regardless of aquifer type – and may be periodically reviewed for modifications that could strengthen protection.
- Private Wells – The state's private well program could be empowered to provide additional tools, training, and best practices for protection of private wells through local health districts and/or directly.

5. **Encourage the use of local development tools:** Through training, information and regulation encourage local governments to incorporate best management practices for water demand management, water efficiency, and water conservation into land-use decisions.

   Technical information, Best Management Practices or regulation may include:

   - Low-Impact Development practices
   - Include water supply and demand management in municipal plans of Conservation and Development.
   - Support tools for implementation of MS4 programs
   - Societal and environmental benefits of urban landscapes, installing climate-appropriate landscapes; using appropriate amounts of soil amendments.
   - Review existing, modify and/or develop controls for lawn irrigation and landscaping practices including landscape-oriented professional education or certification programs.
   - Water rate structures that provide conservation incentive.
   - Provide incentives for maximum-irrigable-area or WaterSense-certified landscapes.
   - Instituting tax incentives for incorporating certain water efficiency measures for high-density developments, such as cluster developments with minimal landscaping needs.
   - Establishing incentives for high-density buildings and developments that incorporate certain water efficiency measures, such as efficient irrigation systems (with plan-check and install-check).
   - Establish structured water or sewer service connection fees and rate structures designed to promote water-wise developments.
   - Create more stringent green-construction codes that include higher-efficiency fixtures and appliances and more water-wise landscapes.
   - Reduce agricultural urbanization and fragmentation of agricultural lands.

6. **Examine barriers in state law for implementing the above local development tools:** Over the next several years, examine barriers local jurisdictions may face while implementing local development tools and utilize Council of Governments to support development of tools and ordinances. Revise state building codes to insure wise water use in building design and development. Delegate additional state authority to local agencies as needed to implement best management practices.

7. **Strengthen partnerships**: To be successful in integrating land-use and water planning, the state will need to partner with many different agencies and groups, both internally and

externally. Within the next two years, establish meetings with various agencies to map out ways in which the state and other agencies can work together on these issues. Sustainable water use practices must be all partners' goals.

- Local municipalities and water providers must implement water and land-use plans. Without their partnership and support of new ideas, comprehensive water and land planning will not succeed. The state should encourage or require, where appropriate, that municipalities served by a water system provide consultation as stakeholders through the WUCC process in the formulation of utility water supply plans.
- Home-building and construction organizations, such as the Home Builders Association, U.S. Green Building Council through its LEED program to support ordinances and practices and designs that enhance future water-sensitive developments.
- Irrigation Association and Certified Water Contractors can assist.
- Landscape Architects and Designers can assist.
- Non-governmental organizations, such as American Planning Association, and economic development councils, can advance land-use and water integration innovation and research.
- Councils of governments make connections between the local and state government levels. Councils of governments can be strong allies in trainings and research about the land-water nexus.

5.2.3.2 Water Quality and Quantity Management

Purpose: As Connecticut plans for its water future, it will be critical to better integrate water quality and quantity planning and management activities. To ensure that Connecticut continues to have access to safe and clean water, the state must prioritize opportunities to address existing adverse impacts to water quality and minimize future adverse impacts. The state already has significant programs and protections in place for Source Water Protection, Public Water Supply Watershed Protection, Drinking Water Quality Management Plans, the Source Water Collaboration, Aquifer Protection, the Clean Water Act, and the Safe Drinking Water Act. Creating a balance between increasing quantity demands and water quality protection and restoration requires on-going dialogue and collaboration at all levels of government.

Notes: This language was derived from discussions of the Policy Committee and workshop stakeholders during the development of the Plan. While originally considered under the umbrella of land use planning, the impacts of future decisions on water quality were deemed significant enough to warrant a separate policy statement.

Suggested Policy Recommendations

1. **Evaluate Effects:** Evaluate the positive and negative effects to water quality associated with proposed water management solutions. Identification of those effects will help define the scope of strategies that entities need to explore to protect and restore water quality.
2. **Define Opportunities:** The state may define opportunities for projects that restore and enhance existing water quality conditions.
3. **Evaluate Green-Infrastructure:** Define green-infrastructure approaches, and explore ways in which entities can use green infrastructure to address water quality.
4. **Project Design and Operation:** Examine ways to design and operate new or existing supply projects to advance water quality protection and enhancement. Actively pursue incorporation of these design and operation considerations into proposed projects.
5. **Reuse Examples:** Identify the role of reuse by developing a library of reuse examples, such as non-potable reuse, graywater use, and the associated water quality issues for each type of reuse.
6. **Stormwater Management:** Explore the role of stormwater management from both a quality and a quantity perspective in order to determine whether stormwater is a viable additional source of non-potable supply to address out-of-stream needs.
7. **Nonpoint Sources:** Address nonpoint sources through ongoing management activities, which play an important role in protecting and restoring water quality for the benefit of future water uses. These activities should include cataloguing and evaluating local-government land-use planning tools that minimize nonpoint-source pollution associated with development. Entities should also explore a comprehensive approach to nonpoint-source management, including water-quality trading.
8. **Climate Change:** Identify the risks of climate change as they relate to integrated water quality and water-quantity management. Develop specific recommendations for addressing these risks.

9. **Requirements:** Explore how entities can most efficiently and cost- effectively integrate the Clean Water Act requirements and Safe Drinking Water Act requirements. Develop specific implementation recommendations.
10. **Solution Oriented Actions:** Continue to engage in creative, solution-oriented actions, such as implementing site-specific standards, temporary modifications, discharger-specific variances, pollutant trading, and conditional 401 water quality certifications; see Section 401 of the Clean Water Act. Continue to improve water quality and protect the high-quality waters that are considered better-than necessary for supporting classified uses. Maintain ongoing, non-regulatory programs, including nonpoint-source management and source-water protection planning. These solution-oriented actions will also be necessary for addressing the effects of climate change.
11. **Regulations:** Review and appropriately modify existing regulations, guidance, and policy documents for new types of wastewater reuse so that revisions will protect public health and the environment, while also providing sufficient flexibility for water providers and water users to develop or promote new water-reuse projects across the state.
12. **Monitoring and Assessment:** Continue investment in statewide monitoring that supports assessment of the quality- and quantity-integration goals and measures.
13. **Consider Trading Programs:** Investigate the potential to develop water quality trading programs. Innovations on water quality trading can promote improvements in water quality from agriculture in lieu of expensive water treatment costs. Science-based trading programs can achieve water quality goals by promoting water quality improvements in source water regions of headwaters of streams and rivers. Science-based water quality trading programs can promote water quality improvements and expand the revenue streams for agricultural producers. Reference the EPA "2003 Water Quality Trading Policy" and the "2007 Water Quality Trading Toolkit for Permit Writers" for state water quality trading program structure guidance.

5.2.3.3 Water Conservation

Purpose: Water savings resulting from water efficiency activities can reduce out-of-stream water demands and support the goal of satisfying all out-of-stream and instream water demands. Conservation can also assist providers in avoiding or postponing the construction and operation of water supply facilities – as well as eliminating, reducing, or postponing emergency water purchases. In addition to these water supply benefits, water conservation activities can help Connecticut achieve other societal, political, and environmental benefits, including:

- Reduced wastewater discharges through indoor savings;
- Increased availability of water for public and environmental needs;
- Demonstration of a commitment to sustainability;
- The meeting of political and regulatory requirements necessary to obtain permitting for local and regional water supply projects;
- Delay of capital costs for new projects; and
- Reduced operations and maintenance expense.

Conservation also acts as a management tool to buffer against drought using long-term conservation strategies, and to address shortages by implementing short-term conservation strategies. Water providers can store as a drought reserve the amount of water they realize through long-term water conservation efforts and use that reserve during periods of shortages. In those cases, more storage may be required to maintain drought reserve.

Water conservation programming takes time to implement and water savings can take time to accrue. Long-term water conservation should be viewed as a long-term investment. The multiple types of Public Water Systems in the state can result in challenges to consistent conservation initiatives.

Water conservation activities statewide are some of the most inexpensive implementation strategies today, and will allow local water providers to be more efficient with the water resources.

Much of water conservation is based – and reliant – on human behavior. It requires constant communication and education to make water conservation a standard community practice (also known as social norming), and to directly influence behavior to achieve water conservation results. At the local water provider level, computer and smart-metering technology have improved greatly in recent years and allow for a direct link between provider and customer. Through this direct link, a water provider can communicate educational messaging about such topics as water consumption targets, water restrictions, and leak detection.

Regarding these recommendations, there are some components that may not be able to be consistently applied due to differences in regulatory and rate-making oversight of different types of water utilities.

Notes: This language evolved from discussions at stakeholder workshops during the Plan development process, meetings of the WPC Policy Subcommittee, and CDM Smith examples from other states that have included water conservation as part of state planning recommendations.

Suggested Policy Recommendations:

1. **Water conservation education outreach**: It is recommended that the state, in coordination with water utilities and their customers, develop an education and outreach strategy that includes water conservation topics. This work will include surveys of public attitudes, and partnerships with water providers and other water educators and should include a focus on educating youth through schools, scout programs, etc. The state should also work with stakeholders to explore means of reducing outdoor water use.

2. **Existing Conservation Plans:** It is recommended that the state consider undertaking a broad review of existing conservation program implementation and identify opportunities for improvement. As part of the review, review nonrevenue or unaccounted water reported in Water Supply Plans or otherwise reported; and address the impact such conservation programs have on utility revenues. Some small systems may show misleading percentages for nonrevenue or unaccounted water, so true volumes should also be considered.

3. **Adopt conservation incentives**: It is recommended that the WPC adopt policies stating that water providers may conduct comprehensive, integrated water-resource planning geared toward implementing water conservation best practices for all customer classes (residential, industrial, commercial) and both public and private water suppliers at high customer participation levels. Specific incentives may be required to encourage meaningful participation levels by all end-users.

4. **Passive conservation savings**: It is recommended that the state document expected passive conservation savings and to track it over time. Passive conservation refers to the natural trend toward lower overall water use as water-efficient fixtures are installed in new homes, and replaced in others. Some utilities have seen significant indoor domestic water use reduced due to passive conservation. Water utilities already document per-capita water consumption in their water supply plans, and this information could be organized in a database for ease of updating and tracking. In addition, it is important to review building codes and zoning requirements to assure that the most effective and efficient fixtures, as well as outdoor watering technology, is kept up to date.

5. **Support water management activities for all water providers**: It is recommended that the state evaluate the funding, technical support, and training necessary to assist water providers in improving the management of their water systems. This will include the use of techniques such as water budgets, smart-metering, comprehensive water loss management programs, saving tracking and estimating tools, and improved data collection of non-customer water uses. Comprehensive water loss program guidance will include supply-side best management activities, including water use auditing, leak detection and repair, and infrastructure replacement programs. Consider public water suppliers' top users to prioritize conservation during certain situations (i.e the top 20 users contacted during drought conditions).

6. **Explore incentives for outdoor water conservation measures**: As part of a broader funding strategy, it is recommended that the state work with stakeholders to explore possibilities for tax-credit programs or other incentives for reducing outdoor water use. The program could incentivize (monetarily or otherwise) water providers to support a variety of options such as

retrofit higher water-use landscapes / support development of irrigation systems with lower water-use landscapes / irrigation systems that preserve the environmental and economic benefits of urban landscape / and encourage more efficient irrigation. Any activities should be carefully coordinated with the recommended outreach program (above).

This recommendation includes developing a type of toolbox, with multiple choices for solutions that work best for water suppliers and their service areas, including a variety of landscape types and outdoor water use reduction methods; which staff could evaluate and implement those most effective for particular cases.

7. **Support local water smart model ordinances**: It is recommended that the state provide training that supports local regulatory efforts that shape the ways in which water utilities respond to droughts (in coordination with the State Drought Plan), and also ways in which new construction interacts with water use. For example, local jurisdictions could craft landscape and irrigation ordinances, education or certification for landscape professionals, green-infrastructure ordinances, and more stringent green-construction codes that include higher-efficiency fixtures and appliances and water-wise landscapes. Consider leveraging the Councils of Government to assist in local adoption.

8. **Evaluation of barriers to green-building and infrastructure:** It is recommended that the state work together with existing agencies to determine which state agencies govern green infrastructure and green-building, identify barriers, and work with the appropriate agencies to adapt regulations to allow for graywater, green infrastructure, on-site water recycling and other aspects of green developments.

9. **Work with Green Industry to support water-efficient landscapes:** It is recommended that the state collaborate with irrigation associations, landscape contractors, landscape architects and designers, urban arborists, landscape-related businesses, environmental groups and property management companies to implement water-efficient landscape installations and maintenance.

10. **Strengthen partnerships:** It is recommended that the state consider partnerships between the following example groups to reach water conservation goals:

    - Local water providers and local governments to implement water conservation programs to benefit their water systems.
    - Intra-state government to coordinate and implement incentives.
    - Home building/construction (Home Builders Association, LEED, U.S. Green Building Council) to implement water-smart homes.
    - Non-governmental organizations (American Water Works Association, Water Research Foundation, Alliance for Water Efficiency) to help educate citizens and advance conservation innovations and research.
    - Academia to bring a consortium of businesses, academia, and others together to examine behavioral science and research conservation innovations.

- Support the development of tools that allow for the enforcement of water use restrictions imposed by individual utilities in accordance with their Emergency Contingency Plans or in state declared emergency.
- Explore water conservation's potential impact on utility revenues and means to mitigate in order to minimize financial disincentives.

5.2.3.4 Consistency with Existing State Plans

Purpose: The overarching goal of the State Water Plan is to "provide balanced water for all uses." Because many existing statewide plans already address water, they must be incorporated into (or coordinated with) the State Water Plan as appropriate. Likewise, there will be cases that the State Water Plan should inform or cause changes to existing statewide plans either as critical addendums or when they are updated and revised.

Notes: This language was derived from WPC, WPC Steering Committee, Policy Committee, and Science/Technical Committee comments on the four white papers completed during Phase I; and from workshops held with the WPC Steering Committee.

Suggested Policy Recommendations:

1. **Acknowledgment:** Connecticut's state agencies and departments are enabled by various Acts and Statutes to develop and administer a range of statewide plans. These plans will coexist with the State Water Plan and neither shall supersede the other unless future legislative action deems such outcome appropriate. This plan will make recommendations that should be (with the encouragement of the Water Planning Council) incorporated into the following plans as they are finalized or when they are updated. The Water Planning Council shall have the responsibility to recommend changes to other plans if they conflict with the State Water Plan, to reach out to other planning groups, and to coordinate comments from other planning groups on the State Water Plan.
2. **Water Utility Coordinating Committee (WUCC) plans:** Currently three regional CT WUCCs are developing the elements of their water supply planning documents; including a Water Supply Assessment, Exclusive Service Area Boundary delineations, an Integrated Report, and an Executive Summary. The three regional planning documents will be compiled into a statewide water supply planning document. While quantitative data collected for the WUCC reports are being used in the State Water Plan, there are other areas of intersecting recommendations from both documents which should be cross-checked for consistency in the future.
3. **Consistency with the *State of Connecticut Conservation and Development Policies Plan 2013-2018*:** In its efforts to balance all water, the State Water Plan should incorporate elements of the six Growth Management Principles of the *State of Connecticut Conservation and Development Policies Plan 2013-2018*: 1. Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure; 2. Expand Housing Opportunities and Design Choices to Accommodate a Variety of Household Types and Needs; 3. Concentrate Development Around Transportation Nodes and Along Major Transportation Corridors to Support the Viability of Transportation Options; 4. Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands; 5. Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety; and 6. Promote Integrated Planning Across all Levels of Government to Address Issues on a Statewide, Regional and Local Basis.
4. **Consideration of the previous *State of Connecticut Conservation and Development Policies Plan 2005-2010*:** The previous plan included some policy statements and objectives related to water that were not specifically listed in the current version of the Plan. It is recommended that the state consider revisiting some of these principles and coordinate between the State Water

Plan and where applicable, the next edition of the *State of Connecticut Conservation and Development Policies Plan.*

5. **Other Considerations for the next *State of Connecticut Conservation and Development Policies Plan:*** The State Water Plan development is well-timed for coordinating applicable policy recommendations with the next edition of the State C&D Policies Plan. For example, the next edition of C&D could explore whether major development should take into consideration the availability of water resources. In addition, as the State C&D Policies Plan also guides state funding, important water plan elements could be recommended for implementation.

6. **Consideration of the State's Economic Development Strategy:** The State's *Economic Development Strategy* is developed by the State Department of Economic and Community Development (DECD). The Economic Development Strategy sets policies and objectives for spurring employment growth through existing businesses and industries as well as others that are desired. The availability of water supply will be critical for many of these businesses, as will the availability of systems to handle and treat wastewater. While balancing water use in Connecticut, the State Water Plan should consider the four objectives of the Economic Development Strategy. These are: 1. Grow the Business Clusters that Drive Connecticut's Economy and Encourage Entrepreneurial Development; 2. Ensure a Workforce that Meets the Needs of the Future; 3. Create Livable, Vibrant Communities; and 4. Invest in Infrastructure and Support Systems that will Foster Business Growth.

7. **Consideration of the State's Green Plan:** The *Green Plan 2016-2020* highlights the State's efforts to acquire lands for public use and benefit. In particular, the Green Plan "gives priority to the acquisition of lands that serve to protect high-quality natural waters and drinking water resources. Clean water, including in our rivers, lakes, and inland wetlands, is essential to life and provide some of the richest wildlife habitat in the state. Land conservation is an important part of watershed management for protecting habitat and water quality against impacts by fragmentation, climate change, runoff pollution, and other threats." To the extent that the Green Plan leads to key land acquisitions, it can affect water management. The setting aside of lands to remain open space in perpetuity will benefit water quantity and quality in the watersheds with the land acquisitions. The Green Plan objectives should be incorporated in the Plan.

8. **Consideration of the Connecticut Climate Change Preparedness Plan:** The Climate Change Preparedness Plan, prepared in 2011, includes numerous strategies and recommendations related to water which should be considered in the State Water Plan. Conversely, the Water Plan's more comprehensive examination of water resources data will provide useful guidance for future responses to climate change and should be considered in future updates to the CT Climate Change Preparedness Plan.

9. **Edits to the Connecticut Natural Hazard Mitigation Plan:** This plan sets policies and identifies actions to reduce the cycle of damage from natural hazards and disasters that occur in the state each year. The Plan describes the state's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis, and furthers shifts the state from a disaster-response driven system to one based on effective hazard mitigation planning. The Plan also references the additional challenges that climate change poses to the state. An update to this plan is

scheduled for 2017-2018, and the State Water Plan may contribute strategies or actions related to flooding and droughts.

10. **Consideration of the State's Comprehensive Energy Strategy:** The energy strategy offers recommendations in five major priority areas: energy efficiency, industrial energy needs, electricity supply including renewable power, natural gas, and transportation. Water conservation is a major recommendation of the energy strategy. Some of the energy strategy recommendations should be incorporated into the State Water Plan.
11. **Input to the State's "Blue Plan":** The Blue Plan will include an inventory of Long Island Sound's natural resources and uses and offer a spatial plan to guide future use of the Sound's waters and submerged lands. While overlap with the State Water Plan will likely be limited, the timing is such that the State Water Plan could contribute recommendations or policy to the Blue Plan.
12. **Consideration of the Statewide Comprehensive Outdoor Recreation Plan:** This plan identifies outdoor recreation issues of statewide significance and evaluates the supply of, and the demand for, outdoor recreation resources and facilities (which may include water-based recreation). The Plan provides guidance to state and municipal officials as they develop and expand outdoor recreation opportunities. Some of the recreational recommendations should be incorporated into the State Water Plan to the extent that they involve water management.
13. **Input to the Sustainable CT Plan:** Sustainable CT is a voluntary, sustainable community certification program currently under development. It will include resources and support to help municipalities implement sustainability actions in a variety of sectors; including natural resources, transportation, infrastructure, public services, planning, local economies, housing, and cultural resources. The Water Plan should contribute recommendations to the Sustainable CT Plan, especially in their natural resources sector which encompasses sustainability actions related to water, stormwater, open space, and agricultural land preservation.
14. **Connecticut Drought Preparedness and Response Plan:** This draft plan, a set of formal operating procedures and administrative guidance for drought planning and response management, is currently being finalized. Drought Plan recommendations should be included in the State Water Plan.
15. **Input to updates of the Connecticut Department of Transportation Strategic Long-Range Transportation Plan:** This 2009 plan is oriented to building and maintaining Connecticut's transportation infrastructure, but does reference climate change and the State Plan of Conservation and Development as considerations in transportation planning. Transportation systems overlay and impact the state's water resources in a multitude of ways and State Water Plan data and recommendations should be considered in updates to this plan.
16. **Water Planning Council involvement in future statewide plan revisions and updates:** The WPC should have an advisory or review role in many of the plans listed above, such that any potential inconsistencies between these plans and the State Water Plan can be resolved through consensus. The WPC, or its designee, will reach out to the appropriate parties to provide relevant information from the State Water Plan to inform and ensure consistency with updates to the plans listed above, along with other future state plans to the extent that they involve water management.

5.2.3.5 Monitoring for Plan Implementation

Purpose: Help ensure that the Plan is implemented in accordance with the 17 requirements of the statute PA 14-163, and with the stated goals of the stakeholders who frame the Plan. The Steering Committee adopted a 25-year planning period with a five year update.

Notes: These recommendations derive primarily from Workshop #3 of the State Water Plan development process, held on January 12, 2017.

Suggested Policy Recommendations:

1. **Track Against Goals:** Develop a method of assessing future decisions in the context of the Plan, its goals/requirements, and its recommendations. The Water Planning Council holds the responsibility to:
    - Review the Plan in its final form to ensure that all goals listed below are addressed satisfactorily.
    - Review each initiative or recommendation that derives from the Plan during implementation or update phases to ensure they are in compliance with (or an extension of) the goals stated below.
    - As necessary, prioritize the goals with respect to their practicality (funding potential and likely support) and their relative effectiveness in achieving the overarching goal of the Plan, which is to "Provide Balanced Water Use for All Needs."

The goals of the Plan, as articulated by the Stakeholders (WPC Steering Committee, including chairs of active subcommittees and work groups), and as derived from interpretation of State Statute PA 14-163, are shown in the list below. This list of objectives was developed during the September 2016 State Water Plan Workshop #1, and represent the summarized goals expressed at that early stage in Plan development.

Full List of Goals Developed from Workshop #1 Discussion and Interpretation of Public Act 14-163

OBJECTIVES OF THE PLAN

- Provide resilient water supply and water quality for ALL current and future water needs using available surface and groundwater:
    - Recreational, Ecological, Drinking water supply (public and private), Agricultural, Industrial / Energy, Commercial, Wastewater Discharge, Economic Development
- Define and address impacts to ecology, environment, public health and safety, economic health, community health, and overall quality of life.
- Develop water management strategies that are resilient to future uncertainty in climate, regulations, and economic conditions.
- Educate citizens on water management programs, policies, and opportunities to participate.
- Manage the cost and security of water supply, treatment, stormwater, and wastewater systems.

OBJECTIVES FOR DEVELOPING THE PLAN

- Make progress on each identified water management option and challenge by drafting a recommended policy/strategy, or formulating a path forward with information needs, decision processes, and methods of conflict resolution.
- Develop an implementable Plan with achievable near-term and long-term goals, reliable funding mechanisms for ongoing planning and infrastructure, and an effective management structure for making decisions on future water uses.
- Produce a plan that is scientifically based and data driven, including costs and benefits of alternatives, while understanding the information gaps.
- Coordinate with other state and local plans

2. **Monitor Against Statute:** State Statue PA 14-163 lists 17 requirements for the Plan. These requirements served as the basis for the formulation of Plan recommendations, through consensus-building with stakeholders. The model Table of Contents prepared by the Other States' Plans Workgroup of the Water Planning Council Advisory Group (2015) included a section for measuring success by identifying "specific metrics against which implementation can be gauged". The Water Planning Council should develop a method to monitor and report on the implementation of the Plan's recommendations to ensure full compliance with the 17 requirements of the statute. The requirements, as interpreted by the stakeholders (Water Planning Council Steering Committee), were subdivided into three categories:

    - Goals, which were used to guide the formulation of Plan Objectives, listed above in [a],
    - Water Management Options, which served as the basis for more specific formulation of alternative ways to help achieve the overarching goal of providing balanced water use for all needs,
    - Other Information Needs, which helped guide technical analysis and the identification of data gaps.

Tables 5-4 through 5-6 list the 17 requirements in the statute in these categories, and the Water Planning Council, or its designee, should take steps to ensure that the Plan, as written, addresses each requirement satisfactorily, and that as recommendations and initiatives that derive from the Plan are proposed, that they link back directly to at least one, and collectively to all, requirements in these tables:

Table 5-4. Goals for the State Water Plan Extracted from the Statute's 17 Requirements

Statute ID #	Goals for the State Water Plan
3	Recommend the utilization of the state's water resources, including surface and subsurface water, in a manner that balances public water supply, economic development, recreation, and ecological health.
4	Recommend steps to increase the climate resiliency of existing water resources and infrastructure.
7	Take into account desired ecological, recreational, agricultural, industrial, and commercial use of water bodies.
12	Take into account the ecological, environmental, public health and safety and economic impacts that implementation of the Plan will have on the state.
16	Develop and recommend strategies to address climate resiliency including the impact of extreme weather events.

Table 5-5. Options for Meeting the Plan's Goals Extracted from the Statute's 17 Requirements

Statute ID #	Options for Achieving the Goals of the Plan
5	Make recommendations for technology and infrastructure upgrades, interconnections and such major engineering works or special districts
6	Recommend land use and other measures, including an assessment of land acquisition or land protection needs, to ensure the desired quality and abundance of water and to promote development in concert with available water resources.
8	Inform residents of the state about the importance of water-resource stewardship and conservation.
9	Establish conservation guidelines and incentives for consumer water conservation with due consideration for energy efficiency.
10	Develop a water reuse policy with incentives for matching the quality of the water to the use.
13	Include short and long-range objectives and strategies to communicate and implement the Plan.
14	Seek to incorporate regional and local plans and programs for water use and management and plans for water and sewerage facilities in the state water plan.
15	Promote intraregional solutions and sharing of water resources.
17	Identify modifications to laws and regulations that are necessary in order to implement the recommendations of the state water plan.

Table 5-6. Additional Items in the Statute for Providing Data to Evaluate Options

Statute ID #	Data Needs for Evaluating Options in the Context of the Goals
1	ID the quantities and quality of water that are available for public water supply, health, economic, recreation, and environmental benefits on a regional basin scale considering both surface water and GW.
2	Identify present and projected demands for water resources on a state-wide and regional basin scale
11	Meet data collection and analysis needs to provide for data driven water planning and permitting decisions.

3. **Updates to Plan:** The Plan will recommend periodic updates and revisions. It is recommended that the Water Planning Council update the Plan every five years and advise the state legislature at least two years in advance of planned updates so that resources and processes can be established and secured.
4. **Identify Funding Mechanisms:** The Plan will identify potential funding mechanisms for Plan implementation and periodic revisions so that costs can be shared equitably. It is recommended that the Water Planning Council explore the benefits and risks of various funding mechanisms as experienced by other states and make appropriate recommendations to the legislature.
5. **Redefine Roles and Responsibilities:** To help with these recommendations, the Water Planning Council should:
    - Seek to redefine its own responsibility/authority to oversee the implementation of the Plan, direct future periodic revisions, and secure funding for associated activities.
    - Upon disbanding of the Steering Committee, establish or designate a standing advisory committee to assist the Water Planning Council with Plan implementation.
    - Review, assess and as necessary, redefine the role of the Water Planning Council Advisory Group (WPCAG).
    - Clearly define specific roles for each of the four Water Planning Council branches during Implementation phases of the Plan, as well as future revisions.

5.2.3.6 Agricultural Practices

Purpose: The following recommendations focus on the recognition and support of agriculture as a sustainable activity in Connecticut, and encourage that the state promote practices that can reduce the impact that agriculture has on water.

Notes: This language was initially prepared by the Policy Subcommittee of the Water Planning Council, and has been adapted to fit the context of the Plan goals.

Suggested Policy Recommendations:

Agriculture is an important economic factor in Connecticut. To help satisfy the overarching goal of balancing all water uses in Connecticut, the state should support farming as a sustainable activity while managing its water use and consumption, and develop best practices for various agricultural activities, by addressing the following recommendations:

1. **As included in the Water Quality Policy Recommendation:** evaluate the positive and negative impacts to water quality associated with proposed water management solutions, which focus primarily on water quantity and agricultural conservation. This awareness of the connectivity between water quantity and quality should extend to any other agricultural initiatives, such as the Natural Resources conservation Service conservation standards. That is, along with promoting efficient use of water, the impacts of any management measure on water quality should be considered. Identification of those effects will help define the scope of strategies that entities need to explore to protect and restore water quality.
2. **Quantification of Water Use by various agriculture activities:** is a critical first step in determining the current demand and use of water by differing crops, livestock, nurseries, etc.
3. **Create Incentives for Water Quality and Reuse Innovation:** Current trends for "locally Grown" food is focusing some growth toward small specialty farms in the state. In order for the agricultural economy to continue to grow in the state, promote water policies that encourage and reward innovations that produce the most "crop per drop". Reference the EPA "2012 Guidelines for Water Reuse" for state regulatory program structure guidance.
4. **Build Partnerships:** Identify innovative solutions through partnerships. Partner with our universities to promote innovations for water use in agriculture to provide demonstration sites and proof of concept for innovations that can be adopted across the agriculture industry. Demonstrations should focus on cost-benefit analyses, conduct risk assessment for innovations, and assess opportunities and challenges associated with taking innovations to scale. Engage science groups and public health departments where applicable.

5.2.3.7 Obsolete Registered Water Diversions

Purpose: The following recommendations focus on the recognition that registered diversions grant, by law, their holders the right to withdraw water up to the stated amount. However, this recommendation also provides steps for a prudent balance between this recognition, a need to reconcile the mathematical overallocation of certain river basins with actual water availability, and a desire to better understand what the maximum realistic use of water is expected to be for each basin in the future.

Notes: This language was derived from workshops held with the WPC Steering Committee, along with Policy Subcommittee meetings.

Suggested Policy Recommendations:

1. **Acknowledgment:** The stakeholders acknowledge that unused diversion registration quantities exist, and that in some cases, could result in overallocation of rivers if the allowable withdrawals are made. Some unused diversion registrations are likely obsolete (no longer used or needed), while others are retained for future use. Registered volumes do not necessarily represent actual overallocation of water as many remain unused or underutilized. In other words, there may be conditions in which available water in rivers is less than the volume of water needs added to the unused registration quantities that are currently issued. It is further acknowledged that some of the unused registration volumes were based on installed capacity of equipment that may not have reflected actual daily use, and that the diversion registration process did not require environmental assessments.

   Note that while some registrations may be unused and never to-be-used and therefore could be considered obsolete (i.e. agricultural that is now residential subdivision), many water suppliers have registrations that enable future water uses that need to be maintained. Water utilities and their associated groups (i.e. Connecticut Water Works Association) should be consulted to consider the impacts of surrendering unused water registrations.

2. **Reporting:** As a first step, this Plan has aggregated and reported the total volume of unused diversion registrations (and permits) in each regional basin. This information is displayed in tables and in graphs, along with water that is expected to be available for use, and all other existing and predicted water uses, both out-of-stream and instream. However, the information on unused registrations and permits has *not* been included in the maps of basin stress risks in the Plan, because these are based either on current use patterns, or projected demand for the next 25 years, which is often much lower than the full volume of the unused registrations. In this way, decision makers can see both a reasonable level of expected use and the (frequently) higher potential allowable use if all registrations were simultaneously and continuously exercised.

3. **Unused Diversion Registrations:** The state should consider a means of identifying whether a diversion registration quantity is obsolete in whole, and if so, removing it from the record. Implementation of PA 04-185 by the DEEP would help to identify obsolete registrations through reporting or failure to report.

4. **Obsolete Registration Quantities:** As a second step, the state should consider a means of identifying whether the quantity associated with a diversion registration is obsolete in whole or in part. Implementation of PA 04-185 by the DEEP would help to identify obsolete registrations

through reporting or failure to report. This could result when there is no use or planned use of a diversion resulting from changes in property ownership, or voluntary surrender of registrations by individuals, utilities, corporations, farms, etc. In other instances, a diversion registration may be in use or held for future use, but the quantity associated with that use may be less than the amount registered. The state may wish to consider incentives for surrender of unused registration quantities that are not needed for future uses, perhaps in the form of permit conditions, a water quantity trading program, etc. Because of the legal status registered diversions hold, a clear mechanism (including likely legislative action) would be needed to allow an unused registration or any unused quantities to be permanently abandoned.

5. **Prudent Planning Targets:** The Plan presents current out-of-stream demand patterns and 25-year future projections in each basin based on population projections by community. In many cases, unused registered diversions far exceed the expected out-of-stream demand in 25 years. For planning purposes – that is, for prioritizing basins for water management strategies and funding, and for making decisions on what types of strategies could be most effective in various basins – it is recommended that the upper limit on expected water use be based on the future demand projections, and *not* include unused diversions beyond those (knowing that it is assumed that if demand is expected to increase in any basin, that the water would potentially be extracted using portions of currently unused registrations and permits). Note that review of unused registration volumes should consider water utilities 50-year planning (which is the usual timeframe identified in water supply plans).

5.2.3.8 Implementation of Minimum Stream Flow Regulations

Purpose: This policy statement is (1) an acknowledgement of the Stream Flow Standards and Regulations (2011) as an important step toward providing water for instream needs, and (2) a platform to suggest ways in which instream needs may be better understood as a result of the state planning process. The overarching goal of the State Water Plan is to "provide balanced water for all uses." This includes both instream and out-of-stream uses, and for the purposes of this plan, the difference between the two use categories is the actual removal of water from a water body, regardless of whether it is returned in whole or in part elsewhere. With this definition, instream uses include water that remains instream for ecological or recreational purposes, while out-of-stream uses include public and private water supplies for drinking water, industrial water, agriculture, etc. Instream uses promote aquatic health, aesthetics, and recreational opportunities but in some cases where they are required by regulations, may have impacts on out-of-stream water uses. Of note are off-ramps/allowable exceptions that apply due to drought triggers or margin of safety triggers that address water availability during times of hydrologic stress.

Notes: This language was derived from workshops held with the WPC Steering Committee and with the WPC Policy Subcommittee.

Suggested Policy Recommendations:

1. **Acknowledgment:** The stakeholders acknowledge the following as it pertains to the implementation of minimum stream flow.
    - In December of 2011, the Department of Energy and Environmental Protection issued Stream Flow Standards and Regulations (Section 26-141b-1 to 26-141b-8, inclusive, of the Regulations of Connecticut State Agencies). These standards require minimum releases of water downstream of impoundments, which may vary throughout the year in some cases, from specific reservoirs in the state. The regulations allow for progressively reducing stream flow releases under dry conditions until such releases are suspended under severe drought conditions.
    - Some reservoirs may also have requirements for downstream releases as permit conditions, as part of a riparian release requirement or flow management plan, or other legal agreements.
    - Historic releases from reservoirs and those releases required by the regulations do not necessarily account for the entire instream flow need in any basin. This Plan has summarized regulatory requirements for reservoir releases to downstream river reaches along with the out-of-stream water uses. This information is included in the Basin Summary Sheets (Appendix D of the State Water Plan). The regulatory releases from reservoirs are depicted as a component of the overall estimated need for ecological flows in each basin.
    - Ecological flow needs are not wholly regulated under current state law. The impact of these needs, which include minimum stream flow requirements, is depicted in the Basin Summary Sheets for use in future planning.

5.2.3.9 Outreach, Education and Public Engagement

Purpose: To achieve a sustainable water future, Connecticut must be a state of sophisticated water users. Connecticut's Water Plan should expand outreach and education efforts that engage the public and promote well-informed community discourse regarding balanced water solutions. The Plan addresses a number of topics that benefit water consumers, including increased conservation, reuse, preservation and enhancement of the natural environment.

Outreach, education, and public engagement efforts during the development of Connecticut's Water Plan were continuous. These activities should be ongoing, iterative efforts. The state needs to continue the leadership it demonstrated regarding outreach, education, and public engagement activities during the development of Connecticut's Water Plan by continuing to aid in research, coordinating efforts, and providing funding and guidance for water education projects statewide.

Notes: This language evolved from discussions at stakeholder workshops during the Plan development process, meetings of the WPC Policy Subcommittee, and CDM Smith examples from other states that have included outreach as part of state planning recommendations.

Suggested Policy Recommendations:

The following recommendations will enhance Connecticut's water outreach, education, and public engagement and advance the water supply planning process.

1. **Create a new outreach, education, and public engagement framework:**
   - For a new framework, structure outreach, education, and public engagement projects that meet specific criteria and guidelines that align with Connecticut Water Plan goals.
   - Use experience memory of current drought to advocate water stewardship. A number of water utilities began conservation and education efforts that could be continued.
2. **Create a data-based water education plan**: The state should create a data-based water education plan to reach key constituencies that may not be active in the Plan development process, such as the general public, municipal government officials and Connecticut State Legislators.

5.2.3.10 Regionalization

Purpose: A central tenet of life in Connecticut is the principle of "Home Rule," which provides for a high level of management authority at the municipal level. While there are examples of regional approaches with municipalities sharing services, such as education (through regional boards of education) and health (through local health districts), Home Rule is ubiquitous among the state's municipalities. In some cases, there has been a regional approach to the management of water.

To be clear, differences attributable to or characteristic of Home Rule in Connecticut are often strengths that build community character and give people and businesses choices about where to be located. However, the solution to some of the state's water challenges in the state could be furthered where municipalities work together and where the state encourages and creates opportunities for cooperation among municipalities on a regional level. A regional approach to the interconnection of water authorities in southeastern Connecticut, for example, has solved water imbalances [the provision of water from Groton Utilities to Montville and the Mohegan Tribe], improved cooperation during day-to-day as well as emergency situations [the Intra-Regional Water Supply Response Plan], and fostered future collaboration relative to identifying new sources of supply [the SCCOG subcommittee for water resources planning]. Its success may have been even greater with the backing of a consensus based water plan, such as this.

The Plan acknowledges that water use challenges are not contained within or bounded by municipal boundaries. Waters are (at a minimum) the waters of the state. Attention needs to be given to watersheds and regional considerations. Over reliance on property tax as a source of municipal revenue may drive water use decisions, leading in some instances to poor decisions from the perspective of water management. Zoning and land use decisions at the local level can affect water use and be decided based upon priorities other than water use or result in outcomes that may be inconsistent with other elements of the Plan.

The purpose of this policy recommendation is to affirm the long-standing reality of Home Rule governance in Connecticut, and to suggest that the state can create opportunities for future beneficial regional cooperation or partnerships between or among municipalities or between municipalities and water utilities, including in the area of system consolidations.

Notes: This language was derived from workshops held with the WPC Steering Committee and meetings with multiple subcommittees and work groups reporting to the WPC.

Suggested Policy Recommendations:

1. **Acknowledgment:** Despite the numerous benefits of local control and citizen involvement with local issues, Home Rule can pose certain challenges when managing water. It is with the recognition of these benefits and challenges, however, that the Plan acknowledges and affirms this form of governance in Connecticut because of its prevailing benefits to communities and their way of life, while supporting the state's encouragement of future beneficial regional approaches.
2. **Opportunities for Municipal Involvement in Broader Initiatives:** In accordance with other recommendations in this Plan, it is recommended that there be outreach to municipal governments when utility water supply plans are being prepared as there is in the WUCCs process. Where appropriate, it is further recommended that the state encourage, support,

and/or incentivize (monetarily or otherwise) inter-municipal negotiations on water sharing, either on an emergency or permanent basis, encourage municipal cooperation when identifying land for open space and recreational use, and support the involvement of the regional Councils of Government.

5.2.3.11 Class B Water for Non-Potable Use

Purpose: The purpose of this policy statement is to acknowledge the Class B prohibition for drinking water and to affirm the great value of such prohibition, but also to encourage consideration of Class B waters for additional non-potable uses where such use can be administered reliably and cost-effectively.

Although we commonly speak of a prohibition of use of Class B waters for drinking water, the specific rule is that Connecticut uses only Class A or Class AA surface waters for human consumption, pursuant to Section 22a-417 of the Connecticut General Statutes, which prohibits wastewater discharge upstream of surface water withdrawals for human consumption. For example, the Connecticut River is not used for drinking water purposes because treated wastewater is discharged into the river (some of which originates outside the state and therefore outside the state's jurisdiction) and it is Class B. This statute often is interpreted as withdrawals for public drinking water supply are not allowed from Class B surface waters (or lesser quality) as these may receive treated wastewater. Public education regarding use of non-Class A water may be needed to reinforce this policy.

This rule has been a mainstay in Connecticut. As a result, public water supply customers benefit from lower risk of consuming contaminants associated with water bodies more susceptible to eutrophication, industrial wastewater, and discharges of sewage effluent. In addition, it is presumed that many of the state's residents are avoiding the potential ramifications of consuming many emerging contaminants.

Water utilities in the state have made significant investment for protection and treatment of source waters to ensure the high water quality that customers receive, including land acquisition and other means of protection. Because of the prohibition against using Class B water for public water supply, these investments have been less costly compared to other states where Class B waters can be used for drinking. Additionally, treating more degraded raw water to drinking water standards could involve more energy intensive treatment processes and this could, in turn, affect air quality and climate trends.

Notes: This language was derived from workshops held with the WPC Steering Committee and meetings with multiple subcommittees and work groups reporting to the WPC.

Suggested Policy Recommendations:

1. **Acknowledgment:** The stakeholders acknowledge that the prohibition of Class B waters for drinking water in Connecticut has been instituted to protect human health. In addition, it has a positive effect on environmental quality because of lower energy needs for treating high quality Class A water for drinking. It is the firm recommendation of this Plan that only Class A waters continue to be used for human consumption, and that Class B waters remain available only for non-potable uses in this state. The Plan acknowledges that there are public drinking water wells adjacent to Class B streams and the protections in the Safe Drinking Water Act apply to these wells.

   However, the Plan also acknowledges that the requirement to use only Class A or AA (or GA and GAA) waters for drinking can place extra burden on streams and their dependent ecosystems.

Providing balanced use of such water for out-of-stream and instream needs (human and environmental health) is the cornerstone of this Plan.

2. **Non-Potable Uses:** The Plan further recommends that current and future non-potable uses of water be reviewed by individual users (with input from utilities and state agencies and coordination with the Siting Council when applicable) to determine if Class B water could be an environmentally prudent and cost-effective alternative to higher quality water. Current uses of Class B water include agricultural and golf course irrigation, energy production, industry, etc., when the use removes water from the stream. In these cases, the intended use must be matched or paired with the water quality. In addition, water left in the stream has many uses including wastewater assimilation, recreation (including fishing), aquatic habitat, energy generation, etc. Collaboration with the private sector could increase these uses. Considerations in evaluating the efficacy of Class B water for non-potable use will vary on a case-specific basis, but at a minimum should include evaluation of the source proximity, reliability, cost of infrastructure and treatment, and suitability of water quality for its ultimate intended use. An example policy directive might be that the Siting Council, when evaluating sites for future power generation, consider whether sites could be served all or in part by Class B water.

3. **WPC Guidelines for Non-Potable Use of Class B Waters:** It is recommended that the WPC provide guidelines for review of Class B water for non-potable uses such that individual users and utilities can evaluate opportunities on a consistent basis, even though individual economic or environmental circumstances may prevail. EPA provides guidance on water reuse that includes guidance for structure of state regulatory program: https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf

   The guidelines should include a framework for evaluating source reliability, infrastructure cost, operating/treatment costs, and any regulatory requirements that may either facilitate or inhibit the conversion to, or use of, Class B water for individual non-potable uses. The guidelines should provide a fair mechanism to assess both whether costs are prohibitive and what the consequences could be of not transitioning to using Class B water for non-potable proposes. A "Triple Bottom Line" approach that considers economic, environmental, and social factors may be an appropriate framework.

4. **Regulatory Requirements:** If there are regulatory requirements that inhibit non-potable uses of Class B waters, or if there is a lack of clarity in the process to use Class B waters, the WPC should explore whether these regulations should be changed or clarity can be defined.

5.2.3.12 Data Availability, Accessibility and Accuracy

[Note that this Section 5.2.3.12 has been updated based on input received in June 2017 from the Steering Committee and the Policy Subcommittee, and therefore discussion regarding this topic, more so than other Recommendations, may need to be continued as part of consensus building.]

Purpose: The overarching goal of the Plan is to "provide balanced water for all uses." Stakeholders agree that access to accurate data is necessary to provide a foundation for planning. The data used for the development of the Plan – largely collected and compiled in the latter half of 2016 – has provided a baseline of reasonable information to conduct analysis and draw initial conclusions. However, additional work is necessary to close gaps in the available data and ensure that it is available going forward. FOI protections from water suppliers make certain data unavailable and will need to be addressed moving forward.

Notes: This language was derived from meetings of the Science/Technical Committee and discussions about the Data Gaps memorandum developed during Phase I of the Plan process.

Suggested Policy Recommendations:

1. **Acknowledgment:** The current version of the Data Gaps discussion is incorporated in Section 2.1.2.2 of the Phase I Report, entitled "Current Data Gaps." Section 2.1.2.2 should be consulted if further information is needed.
2. **Coordination of Data Collection and Monitoring:**

   - **Coordinate Ongoing Monitoring:** Ongoing environmental monitoring activities related to water and/or land use should be tracked and coordinated at the state level. This includes, but is not necessarily limited to, data on water quality, quantity, groundwater levels, wastewater discharges, and water usage, as well as data on land use. Ideally, one or more agencies would be tasked with the tracking of all ongoing environmental data gathering through coordination with federal, state, and local organizations, non-profit groups, and water users, and this data would be stored centrally as discussed in Recommendation 1b, below. It is recognized that the quantity and broad nature of these data presents many challenges to such a centralized tracking system and that this is a goal that will need to be pursued on a long-term incremental basis.

     Especially important is maintaining and enhancing funding for existing public and private partnerships concerning USGS real-time and discrete monitoring programs, including stream gauging, water quality, and groundwater levels.

   - **Centralize Data Storage for a Portal:** To the extent practical and feasible, water data necessary for future water planning and for Plan implementation should be centralized to enhance the efficiency of future planning and Plan updates. The state should establish a single database or portal that will serve as a repository for ongoing and future water and environmental monitoring data. The database could include links to outside organization information (such as USGS, NCDC, and State Agency databases).

   - **Streamflow Regulations:** Stream Flow Regulations have effects on available water for public drinking water supply, current safe yield, and future safe yield, along with other factors such as nonrevenue figures and peaking factors. It is understood that effects to safe yield and Margin of Safety are being calculated by some water utilities and may be reported

as part of the Water Utility Coordinating Committee (WUCC) process, while other water utilities are conducting analysis when individual water supply plans are updated; either way, the information should be incorporated into implementation decisions for the Plan.

- **Private Well Records:** Well completion reports are required to be filed with the Department of Consumer Protection and DEEP, and exist as paper copies and tagged image format (TIF) files. Going forward, the information on all new well completion reports (location of well, type, depth, diameter, yield, static water level, key geologic information) should be entered into a database to be maintained by the Department of Consumer Protection and/or another agency. As resources permit, existing logs should be entered into the database.

3. **Public Water System Data:** The Plan supports ongoing efforts to make additional planning data available from Individual Water Supply Plans while protecting security sensitive information to protect the safety and quality of water systems.
4. **Registrations:** Reporting of registered water diversion withdrawals is essential to water planning. The Plan supports the finalization and distribution of the reporting form required by Public Act 04-185. This will help accomplish collection of data in a standardized manner that will facilitate using it for future planning efforts.
5. **Withdrawals:** Community water systems are required to meter withdrawals; however, not all of this data is readily available. The Plan recommends a reasonable policy that results in phased-in requirements for reporting that are not cost prohibitive or overly burdensome to public water systems and other types of water users.
6. **Transfer of water among public water supply diversions and reservoirs:** For some basin studies that are undertaken at a subregional basin scale (or smaller), it will be important to understand the quantity and rate of transfers between sources of supply that lie in different subregional basins. Because subregional basin studies may be recommended by the Plan, it may be prudent to promote reasonably accurate estimation of surface water transfers. The water utilities will be responsible for these estimates; thus, their input – individually or via CWWA – will be important.
7. **Other data gaps:** As time and funding permits, other data gaps should be identified and addressed. Among these data gaps are water demands from agricultural uses, turf grass management, landscaping irrigation, and water diversions less than the 50,000 gallons per day permitting threshold. Means to fund additional water data collection programs, such as stream gages, groundwater levels, water quality, and real-time monitoring networks, will improve data accessibility and management of the state's water resources.

5.2.3.13 Coordination with Water Utility Coordinating Committees (WUCCs)

Purpose: The overarching goal of the Plan is to "provide balanced water for all uses." Public water supply is one of these uses. The state has a process in place (the "coordinated water system planning" process) to coordinate public water supply and public water service. Coordinated water system planning is conducted by the Water Utility Coordinating Committees (WUCCs). Per Public Act 85-535, the Department of Public Health is responsible to administer and provide oversight of the WUCC process. The state is divided into three public water supply planning areas – West, Central, and East – and the WUCCs convened in June 2016. This policy statement is an acknowledgement of the coordinated water system planning process.

Notes: This language was derived from workshops held with the WPC Steering Committee.

Suggested Policy Recommendations:

1. **Acknowledgment:** Connecticut's public water supply planning process was prompted by the state's extended drought in the early 1980s. During the 1985 Legislative Session, the Connecticut General Assembly passed Public Act 85-535, "An Act Concerning a Connecticut Plan for Public Water Supply Coordination", initiating the first statewide water supply planning program. The legislative finding, as reflected in Section 25-33c of the CGS, states the following: "In order to maximize efficient and effective development of the state's public water supply systems and to promote public health, safety, and welfare, the DPH shall administer a procedure to coordinate the planning of public water supply systems.

   The Plan and the Water Utility Coordinating Committees operate under separate statutes and have different approval processes. Both processes are running in parallel and have different end dates.

2. **Consistency between State Water Plan and Coordinated Water System Plans:** The Water Planning Council desires consistency between the Plan and the Coordinated Water System Plans for the West, Central, and East public water supply management areas. While striving for consistency, the WPC and the WUCCs shall understand that neither planning process drives the other; and inclusion of recommendations in one planning process does not imply inclusion of the same recommendations in the other planning process. The Water Planning Council must develop a method to resolve conflicts between the Plan and the Coordinated Water System plans.

3. **Issues, Needs, and Deficiencies Identified in the Final Water Supply Assessment reports for the West, Central, and East regions that are germane to the Plan should be considered:** These may include issues, needs, and deficiencies related to the items listed in CGS 25-33h:

   - Integration of public water systems
   - Integration of public water system plans
   - Exclusive service areas
   - Joint management or ownership
   - Satellite management

- Interconnections
- Integration of land use and water system plans
- Minimum design standards
- Water conservation
- Effects on other uses of water resources including water quality, flood management, recreation, and aquatic habitats
- Acquisition of land surrounding wells

4. **Findings, Challenges, Options, and Recommendations Identified in the Plan should be recognized and considered in the Integrated Reports:** Upon completion of the draft State Water Plan in 2017, its findings and recommendations should be considered in the Integrated Reports of the three Coordinated Water System Plans, and incorporated as applicable.
5. **The WUCCs May Become Vehicles for Implementation of Some State Water Plan Recommendations:** Because the WUCCs will continue to exist in accordance with their enabling statute, comprised of public water systems and the State's Councils of Governments, they may emerge as vehicles for implementation of some low-cost (or no-cost) recommendations from the Plan (working with the Water Planning Council and/or future authorities).

5.3 Recommended Pathways and Frameworks for Future Decisions

5.3.1 Introduction

Not all water issues were resolved (or expected to be resolved) by Water Planning Council and Steering Committee member consensus during the one-year planning process. Those that were, are listed and explained with policy recommendations in Section 5.2. Issues for which consensus requires additional work before recommending policies that are mutually agreeable to the Water Planning Council member agencies and their stakeholders are included in this section.

Planning is an ongoing process. Many issues identified by the Plan statute or by stakeholders during the planning process yielded productive dialogue, but not necessarily a clear consensus on policy recommendations. Rather, needs were identified for additional information, possible partnerships, and opportunities for facilitated consensus-building before recommendations can be made with broad stakeholder support. For each of these issues, the Plan has prepared a series of Next Steps, or "Pathways Forward," which are intended to help the WPC and its stakeholders advance each unresolved issue closer to consensus. Even if consensus cannot be fully achieved, these next steps could help educate decision makers on the benefits and disadvantages of future water management strategies, so that legislative and regulatory decisions can be more informed than they would be today.

The next steps are offered as suggested ideas, to be advanced or initiated at the discretion of the WPC based on its priorities and available resources. None of the suggestions are mandates or requirements, and they do not represent recommendations for changes in policies, laws, or regulations. They are intended to serve only as menus of ideas that can improve the clarity with which the WPC advances (or elects not to advance) these issues in the future.

For each issue that requires additional steps if consensus is to be reached, the Pathways Forward include 3 types of recommendations:

- Additional Information Needs, intended to provide stakeholders with more complete data, opinions, case studies, and impact assessments with which to continue the dialogue.
- Possible Partnerships, which may provide both an impetus and a mechanism for accomplishing fact-finding, pilot studies, or even implementation of progressive water management techniques.
- Opportunities for Consensus Building and/or Communication, intended to gather public input and support, or facilitate formal dialogue between stakeholders or interested participants in an implementation effort.

Unlike the policy recommendations, where the intent is for the legislature to adopt the draft policies as guiding principles for future laws and regulations, these next steps are suggested opportunities specifically for the Water Planning Council. Legislative authorization and/or funding may be needed to take certain steps. In other cases, the intent of these steps is that they be implemented under the authority and discretion of the Water Planning Council. They are intended to serve as reasonable opportunities that the Water Planning Council could undertake in the future

to clarify certain issues or draw stakeholders closer to consensus for future policy recommendations.

During Workshop #3, stakeholders separated issues for which consensus was likely from those for which additional information or outreach (Pathways Forward) would be needed. **Table 5-7** lists the issues requiring Pathways Forward. Other issues, where consensus was deemed likely, are addressed in Section 5.2 (Policy Recommendations). Subsequently, in Workshop #4, the stakeholders began to develop lists of possible and reasonable next steps to help inform five of these issues, while others were developed collaboratively between the consultant and the WPC.

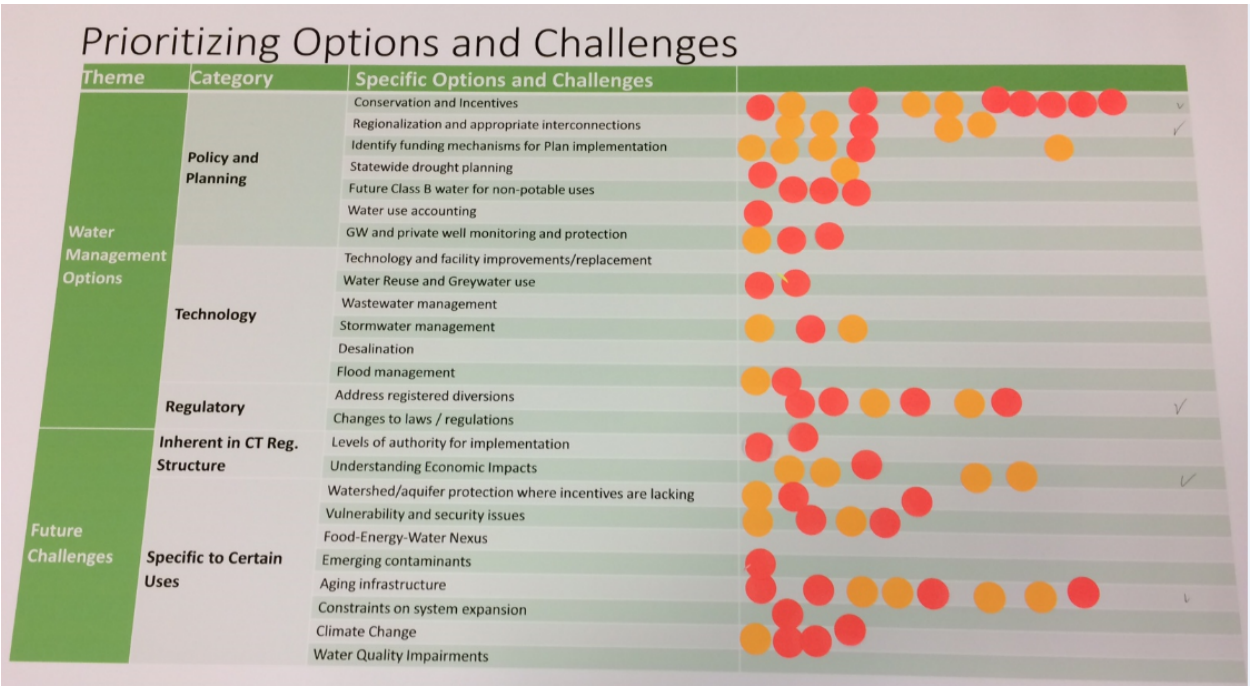
The Pathways are grouped into three categories in the sections below:

- **Pathways developed with Stakeholders** (Section 5.3.2.1 through 5.3.2.5): These lists of possible next steps were developed collaboratively with stakeholders during the workshop process.
- **Pathways developed with the WPC** (Section 5.3.2.6 through 5.3.2.11): These lists were developed directly with the WPC.
- **Other Pathways Grouped by Theme** (Section 5.3.2.12 through 5.3.2.14): These lists cover broad topics with many possible subdivisions, and it was deemed that consolidating them thematically was efficient. The two themes were "Overcoming Future Challenges" and "Technology Issues." 5.3.2.14 is the Pathway Forward on Private Wells, which was developed following other pathways.

Table 5-7. Categorization of Pathways Forward

Theme	Category	Specific Options and Challenges
Water Management Options	Policy and Planning	Conservation and Incentives
		Regionalization and appropriate interconnections
		Identify funding mechanisms for Plan implementation
		Statewide drought planning
		Future Class B water for non-potable uses
		Water use accounting
		GW and private well monitoring and protection (grouped with Watershed/Aquifer protection, below)
	Technology	Technology and facility improvements/replacement
		Water Reuse and Greywater Use
		Wastewater management (combined with Reuse, above)
		Stormwater management
		Desalination
		Flood management
	Regulatory	Address registered diversions
		Changes to laws / regulations
Future Challenges	Inherent in CT Reg. Structure	Levels of authority for implementation
		Understanding Economic Impacts
	Specific to Certain Uses	Watershed/aquifer protection where incentives are lacking
		Vulnerability and security issues
		Food-Energy-Water Nexus
		Emerging contaminants
		Aging infrastructure
		Constraints on system expansion
		Climate Change
		Water Quality Impairments

	Developed with Stakeholders (Section 5.3.2.1)
	Developed with WPC (Section 5.3.2.2)
	Grouped into “Overcoming Future Challenges” (Section 5.3.2.3)
	Grouped into “Technology Issues” (Section 5.3.2.3)



5.3.2 Summary of Pathway Forward Opportunities

Pathways Developed with Stakeholders

The following five Pathways were identified by stakeholders during Workshop #4 of the Plan development process as issues that were important to work on collaboratively. As such, the stakeholders (WPC Steering Committee) developed the list of next steps during the workshop, and they have been refined by the consulting team herein. The fact that the stakeholders selected these five issues reflects their preference for developing the next steps collaboratively in the workshop, and does not necessarily translate into policy priorities.

The five Pathways selected for collaborative development by the stakeholders include (as shown in the figure below):

- Conservation and Incentives
- Regionalization/Interconnections
- Addressing Registered Water Diversions
- Aging Infrastructure
- Economic Impacts

5.3.2.1 Water Conservation

Purpose and Background

This pathway complements the policy recommendations for water conservation, as some components of water conservation are easily brought to consensus, while others need a pathway forward to discuss appropriate next steps. For example, using smart outdoor watering techniques such as moisture-sensing devices and timers are likely brought to consensus. However, other outdoor uses such as golf courses and car washes have other societal, recreational and economic impacts that require consensus building for appropriate recommendations.

Information Needs

- Identify conservation incentives that have been successful in Northeast US.
- Identify case studies in CT, including possible pilot cases.
- Address residential and nonresidential conservation to ensure they are fair and balanced.
- Estimate passive conservation savings potential, and explore ways to accelerate with incentives. Determine whether older appliances and fixtures with higher flow rates are rare or worth incentivizing (monetarily or otherwise) replacement.
- Monitor water use for plan update, as PWSs have said that they expect a continuous decrease in water demand of about 1% each year.
- Billing frequency – study ongoing efforts (for example, MDC has converted to monthly billing) and the associated administrative efforts and costs, and whether the month-to-month comparison incentivizes (monetarily or otherwise) customers to monitor water use.
- Study and report on the role of the municipalities and regional/local entities including COGs, LHD and local commissions.

Possible Partnerships

- Partnership with Alliance for Water Efficiency.
- Work with utilities on outreach/education including the CT Section AWWA Education and CT Section AWWA Sustainability Committee.
- As applicable, coordinate conservation and incentives with interconnection planning.
- As applicable, coordinate with "Sustainable CT" initiative.
- Consider potential for the state to adopt EPA's Water Sense Standards

Consensus Building and Communication

- Statewide consistency in conservation guidance.
- Encourage green infrastructure to reduce dependence on water for landscaping and other outdoor needs (use examples in CT – United Technologies, Coke …).
- Coordinate with land use and development decisions.

5.3.2.2 Regionalization/Interconnections

Purpose and Background

The suggestions below are offered as steps that Connecticut should consider both generally, and on a case-by-case basis when interconnections or consolidation of water services appear to be a reasonable option for certain municipalities or regions. These suggestions were not codified into a policy statement because there is no universal problem that regionalization and interconnections would be aimed at solving (although there are several local pollution issues i.e. Durham, New Fairfield and Tylerville), and no true consensus on the strategic value of statewide directives on this issue.

There are pros and cons to consolidation of Public Water Systems; some smaller systems may have poor infrastructure without means to correct, however the presence of numerous systems in the state helps protect many state residents in cases where some systems may be compromised. Some stakeholders have expressed opinions that fewer Public Water Systems would increase resilience (fewer opportunities for system failures or shortfalls), while others have offered a counterpoint that the numerous smaller systems throughout the state reduce the risk of major shortfalls to larger, consolidated water and/or wastewater systems.

The use of interconnections for emergency purposes and resiliency may be closer to consensus. In some cases, interconnections may provide opportunities for conjunctive management of water sources and flexibility to relieve environmental stress on specific sources.

Note that while this pathway focuses on drinking water regionalization, discussions including information needs, partnerships and consensus building, are similarly applicable for wastewater: including decentralized wastewater treatment systems and small community wastewater systems, and the corresponding data needs and potential policy components.

Information Needs

- **Case Studies:** The WPC could commission the documentation of several case studies on regional water planning, including: the interconnection in Southeastern Connecticut via the regional pipeline from Groton Utilities, and the regional cooperation exhibited by New London/East Lyme water banking. It is recommended that the impetus for each case study be documented, the opinions for and against the decisions that were made, and ways that the outcomes were measured or evaluated. This could be accomplished through subcommittees or work groups.
- **Pros and Cons of Regionalization**: The DPH website includes up-to-date information on the various sizes, number and quantity of water systems in state as part of their *Public Water System List*. The WPC could commission a white paper assessment of the advantages and disadvantages of having so many (~2500) separate water supply systems in the state (as introduced in the Purpose Section, above). The assessment should include impacts and benefits related to supply reliability, resilience, water quality, treatment needs, ecological health, and economics. This could be accomplished through subcommittees or work groups. The paper should also consider the risks of interconnections through rural areas, the potential for induced growth where it may not be universally desirable, and the regulatory restrictions imposed as a result of interconnections.

DPH also has a Three Storm Strategy, which is an ongoing strategic initiative developed following Storm Sandy, that focuses on small system capacity and initiatives to address aging infrastructure and provide technical assistance.

- **Incentives and Drivers:** An evaluation of historical and potential reasons for regionalization should be completed.
- **Guidelines for Determination:** The WPC could develop guidelines to determine the benefits of interconnections between municipalities, or between transmission lines and local service lines. Evaluation of those benefits may be based on pipeline routes, development goals, water needs and/or other factors.
- **Infrastructure Capacities:** Coordinate with existing informational sources for infrastructure capacities, including treatment capacities, withdrawal and discharge permits, safe yield, transmission capacities, etc. The WUCC processes and reports may be one source for some of this information, including that the WUCC process has identified potential interconnections that would address some water quality and aging infrastructure issues.

  Infrastructure information may also be part of various resiliency programs via CIRCA via DOH HUD funding, DPH and DEEP funded projects, including those projects aimed at reviewing system vulnerability and interconnections (i.e. interconnections to address vulnerabilities in the state's four southern counties.

Possible Partnerships

- Partnerships will emerge as potential opportunities for interconnection and/or system consolidation arise.
- DPH departments including local health departments, to coordinate with private wells (and decentralized wastewater systems), and any known issues that regionalization may affect. The Environmental Health and Safety section at DPH should also be considered for partnerships were appropriate.
- The Water Planning Council Policy Subcommittee has developed guidelines for temporary and permanent interlocal interconnections, with near consensus. They are included under Consensus Building (Section 5 of this document) for consideration of the Water Planning Council.

Consensus Building and Communication

- **Coordination with State C&D Plan:** The WPC could coordinate with the planning activities for the State Conservation and Development (C&D) Plan to help ensure that regionalization of water and/or wastewater is compatible with other goals.
- **WPC Facilitation**: The WPC could consider serving as facilitator for non-binding mediation and negotiation when beneficial opportunities for regionalization and/or interconnection arise. This may help interested parties navigate existing barriers consistently, and ultimately diminish the burden of such. Current barriers may include:
  - Lack of funding or financial incentives
  - Home Rule

- The fact that Connecticut has three (3) different administrative types of Public Water Supply systems: Private investor-owned, Regional quasi-governmental, and Municipal. Each type has different funding mechanisms, rate structures, and expense structures that could complicate water sharing without consistent guidelines and/or facilitation from the WPC.
- Environmental effects to donor and receptor basins
- Inconsistency with local, regional, and state plans

- **Advance Policy Subcommittee Language:** There was agreement that interconnections between public water supply systems have multiple benefits, and the Plan should encourage interconnections, with controls and considerations appropriate to the purpose of the interconnections.

  Example Policy: (Needs Consensus)

  Promote legislation, regulation and regulatory administration that reduces barriers and provides incentives for water utilities to construct permanent interconnections that can be utilized on a short-term basis to provide reliability during emergency situations without impacting the system's margin of safety.

5.3.2.3 Registered Water Diversions

Purpose and Background

This pathway complements the policy recommendations for addressing Registered Water Diversions.

When the diversion regulations (CGS §22a-367 - §22a-379) were established in 1982, a provision was included to grandfather existing diversions through a registration process. Existing diverters were allowed to register the location, capacity, frequency, rate of withdrawal, and description of water use and water system. The registration allows for continued use of the diversion without regard to environmental effects or effects to other water users. In many cases, the volume of the withdrawals registered were the maximum ever withdrawn from the source, or the reservoir or pump capacities. Withdrawal volumes are typically much less than the registered volume, although the diverter has the right to withdraw the full registered volume. PA 04-185 allows for reporting of registered withdrawals pending development of a reporting form.

There is evidence that some registered diversions are causing environmental impairments by removing water from streams. In some instances, such as the Fenton River in 2005, groundwater pumping desiccates the streambed and has caused fish kills. Climate change and/or watershed development may make this a more frequent occurrence. During development of the Plan, participants and commenters have expressed concern about the potential effects of the registered diversions and sought opportunities to remedy this. Even where registered diversions are not causing impacts, and there is not a concern, the uncertainty of timing and use of registered withdrawals may present one in the future, as the owner of the registration could exercise their rights to withdraw water at any time. However, where an impairment is being created, there needs to be a mechanism to manage the impairment. Effective policy must be established through the Plan to moderate the impact of registered diversions that are causing impairments.

Information Needs

- Work cooperatively to define parameters for when an impairment is occurring. A desiccated streambed is not the appropriate standard as harm begins substantially before a stream is dewatered.
- Defining the extent of the problem – where are registered diversions causing adverse environmental impacts now?
    - Build off of DEEP's photo-documentation project: Photo documentation is a cost-effective supplemental monitoring technique that provides qualitative and semi-quantitative data on changes in streamflow over time. Registered diverters could follow DEEP's protocol on photo-documentation.
    - Conduct desktop screening analysis of registered diversions to determine degree and likelihood of significant flow impairments following implementation of the Streamflow Regulations, considering existing and forecast water usage.
    - Engage registered diverters with high likelihood of impairment to document whether their withdrawals are causing impairments or not
- Assess where the use of unused allocations within registered diversions could cause adverse environmental impacts through continuation of DEEP's analysis.

- Case studies: Environmental impacts, e.g. Coppermine Brook; Management plan options, e.g. Fenton River
- Monitoring to enable prediction of future issues (once a threshold is exceeded or if actual impairment occurs, could trigger the need for alternatives planning).
- Assess potential funding mechanisms for technical assistance, operational improvements, and/or capital improvements to address potential or identified impacts while meeting out of stream water needs.

Possible Partnerships

- CWWA white paper has been developed in November 2016 "Diversions Registrations and Water Planning a Proposed Approach"; work with CWWA and its members. That white paper includes the following statement "Potential solutions can only reasonably be expected to be developed if: decisions are based on sound data and science; incentives are provided for diversion holders to alter any of their current rights; and adequate safeguards are included such that any change to the status quo and new regulatory construct ensures that current and future water supply needs can be met without undue burdens on water utility customers."
- Reach out to diversion registration holders to inquire about intent, incentives to abandon unused portion, the potential to convert for emergency usage only, etc.

Consensus Building and Communication

- Consider a formal process for voluntary abandonment of registrations.
- Develop list of possible incentives so that individual discussions can be tailored to actual needs, such as waste load allocation adjustments, financial incentives, training assistance, permit schedules, regionalization incentives, etc. Other win-win incentives that could reduce environmental impact while increasing resiliency may include facilitating interconnections, flexibility to modify registrations to increase allowed withdrawals, relocate point of withdrawal, modifying DEEP recognized service areas if overall negligible or lesser environmental impact and other areas of balanced consideration.

Summary of Action Items for WPC

- The WPC can consider the collection of additional data to support ongoing monitoring and decision making:
  - The WPC could request Connecticut DEEP issue the annual reporting form for registered diversions in accordance with Public Act 04-185 and CGS Section 22a-368a in order to obtain current usage data for registrations each year.
  - The WPC can consider providing more detailed examples or case studies of the effects of over-allocation of basins. While the Plan identifies some historic examples of over-allocation due to registered diversions that are in use, these examples have varying degrees of specificity related to extent of impacts. A case study of the potential impact of over-allocation related to the unused registration quantities on a particular subregional basin may be of interest.

  - The WPC can consider providing more detailed examples or case studies of how problems concerning over-allocation of basins have been solved in the past, such as flow management plans, instream flow studies, adjusted operating rules, etc.

- The WPC can consider forming partnerships for further investigation of this topic:
  - The WPC can consider discussing with registered diversion stakeholders the potential for legislative refinement regarding registration modification / registration exchange / abandonment of unused portion of registered quantities / abandonment of unused registrations / creation of an "emergency" registration category where the registration is for emergency usage only.
  - The WPC could work with registered diverters to establish a trigger for evaluation of a mechanism to manage impairment. Diverters could monitor nearby streams, and continue use of their registered diversion until they reach the trigger level, in which they should follow their Flow Management Plan.
  - Based on facilitated discussions, the WPC can consider developing a list of possible incentives so that individual discussions can be tailored to actual needs, such as waste load allocation adjustments, ecological needs, financial incentives, training assistance, permit schedules, regionalization incentive, etc. Other win-win incentives that could reduce environmental impact while increasing resiliency may include facilitating interconnections, flexibility to modify registrations to increase allowed withdrawals, relocate point of withdrawal, modifying DEEP recognized service areas if overall negligible or lesser environmental impact and other areas of balanced consideration.
- The WPC can consider providing a framework for statewide policy decisions:
  - The WPC could determine a potential legislatively-authorized process for registration abandonment and registration modification, including all or a portion of the registered quantity, which would be effective periodically or in perpetuity. This could include an incentive-based program promulgated by Connecticut DEEP.
- The WPC can consider legislation as needed to provide authorities for the above.

5.3.2.4 Aging Infrastructure

Purpose and Background

Many water, wastewater, transportation, power and other structures and facilities necessary for public use exist in various stages of age and condition. In addition to age, locational factors including low elevations near watercourses or Long Island South make flood and storm resiliency measures also important factors when considering upgrades. In order to maintain infrastructure in good working condition, maintenance and replacement must be planned and the components need to be able to handle or quickly recover from disruptive events.

This section includes potential pathways forward related to water supply and distribution infrastructure, although other infrastructure needs may also be related and should be considered as appropriate, i.e. private wells and wastewater collection and treatment, both centralized and decentralized. Public health and environmental protection corresponding to these infrastructure needs correlate, i.e. aging wastewater and drinking water infrastructure. Another reason to consider these multiple infrastructure types and needs is that often a municipality may need to prioritize funds and efforts towards one or the other, meaning competition between types of infrastructure upgrades.

Information Needs

- Defining the problem related to water quantity and quality: water loss from leaks and the associated lost cost of the water, along with costs of repair and disruption from any major water main breaks.
- Consider studies or examples where unaccounted for water (UAW) is used as a tool to compare against age of infrastructure. Sometimes the age of pipes correlates well with condition, while other factors including material type, manufacturer and even specific installation years affect condition. For example, some pipe installed in the 1970s may be deteriorating at a quicker pace than pipe installed many decades earlier.
- Evaluate and incorporate the needs survey as a 20-year study. CT DPH is expected to issue a report on needs survey in 2017. Depending on availability, the Plan should incorporate recommendations from that needs survey.
- Utility asset management plans. Pipe replacements: based on historical breaks, age, material and other factors. Some locations (shoreline) may have soil or other impacts that age pipe. Other source related infrastructure including well redevelopment/reactivation needs should also be considered.
- Consider updating the report on aging infrastructure that the WPC Advisory Group previously completed. The WUCC process has planning information regarding drinking water issues, and as available, equivalent information on wastewater and stormwater should be incorporated.
- Evaluate the Clean Water and Drinking Water State Revolving Funds (CWSRF and DWSRF) EPA Needs Survey results as an information source for multiple types of infrastructure. Those results include information on state water and wastewater infrastructure needs, along with stormwater and combined sewer overflow (CSO) needs.

Possible Partnerships

- Coordinate with WUCC for water loss evaluations, including specific data on actual vs. unmetered/ unaccounted for water vs. non-revenue water.
- Coordinate with DPH on needs survey as noted above.
- Consider how ratepayer and Water Infrastructure and Conservation Adjustment (WICA) program could apply to municipal and regional utilities.
- Coordinate with CT Conference of Municipalities (CCM), CT Council of Small Towns (COST) and business groups.
- Water pollution control authorities (WPCAs) for wastewater, stormwater management groups, local health departments and/or councils of governments may be partners.

Consensus Building and Communication

- PWS, WPCA and other applicable groups responsible for infrastructure maintenance, upgrades and replacements.

5.3.2.5 Economic Impacts

Purpose and Background

This Plan is not recommending any specific new projects, and so it does not include costs or traditionally-calculated economic benefits associated with specific investments. Rather, it recommends policies that are aimed to serve as guiding principles for future decision making, and steps to further investigate and characterize opportunities for water management in the future. The purpose of the steps outlined below is to develop a framework with which the policy recommendations of the Plan can be evaluated on economic terms. Additionally, these steps encourage the state to adopt a "Triple Bottom Line" approach to economic assessment, whereby policies and even projects are evaluated for their costs and benefits with respect to money, social, and environmental health. While the triple bottom line approach is based on three parts: social, environmental (or ecological) and financial; evaluation of Plan components should consider various subcategories to each of those categories, public health would be a component of both social and environmental categories.

Information Needs

- The Plan will make specific policy recommendations on such issues as Water Conservation, Consideration of Class B Waters for Non-potable Use, Data Gathering, etc. Whether the recommendations require commissioned studies or investments, or dedicated time of state staff, the initiatives bear some cost. An overarching evaluation could be conducted to determine the cost of implementing the Plan and its recommendations, vs. the costs of NOT implementing the Plan. This could be purely financial, or could be aligned with the "Triple Bottom Line" approach, discussed above.
- The WPC could determine whether there is a consistent way to monetize the value of water, given the different types of utility ownership structures, and different uses of water. The intent is not to characterize water as an economic commodity for profit, but to help establish the economic value of any and all uses of water so that these may be compared in the "Triple Bottom Line" framework of social, environmental, and economic factors.
- The WPC could consider a "Lessons Learned" Case Study and how water related to economic competitiveness for business and residential population growth.
- The WPC could consider cataloguing information on infrastructure, water sources, and permits/registrations for cities or utilities that may be currently oversized (based on historically perceived needs) and which could support economic growth more readily than others (i.e. Waterbury).

Possible Partnerships

- Consider collaboration with Sustainable CT to address the issues above.
- Consider partnering with colleges and universities to address the issues above.
- Consider consultation with the US Corps of Engineers and other established experts on water economics – standard methods do apply to monetizing water, though they may not be applicable to all non-federal uses.

Consensus Building and Communication

- Consider communicating policy recommendations and/or new projects with "Triple Bottom Line" evaluation (economic, social, and environmental). This could be useful for any future water decision, including Class B water for non-potable uses, water conservation, water bottling, use prioritization, etc. This approach requires quantitative and qualitative assessments, but is a very useful way to help the public and its representatives understand the range of impacts and benefits for any resource management decision.
- The WPC could formulate a template such that all water-related proposals that go to the legislature have a financial analysis based on common principals.

Other Specific Pathways

The following Pathways were developed by the consulting team based on committee meetings, workshops, and other discussions. The fact that they are not included as high priorities is not indicative of their relative importance, but rather, the stakeholders' decision to focus their collective attention on other issues during the workshop.

The Pathways included in this section include:

- Funding for Implementation
- Future Class B Water for Non-potable Uses
- Statewide Drought Planning
- Wastewater and Water Reuse
- Water Use Accounting
- Instream Flow: Ecological Flows and Minimum Stream Flow Standards

5.3.2.6 Funding for Implementation

Purpose and Background

The Plan must identify methods of funding the implementation of various policy and project recommendations and set priorities for funding.

Information Needs

- List of recommended policies and projects.
- Identification of agencies, departments, committees that should be responsible for administration and/or execution of recommendations.
- Cost estimates for recommended projects, studies, agency staffing, etc.
- Identification of possible funding paradigms based on other states.

Possible Partnerships

- OPM for broad planning capabilities related to funding
- DEEP for CWSRF, Section 319, etc.
- DPH for DWSRF
- PURA for utility-funded recommendations
- The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) for resilience-related funds (two existing nominal grant programs)
- UConn, the Connecticut Institute of Water Resources (CT IWR), CLEAR, and other UConn entities
- U.S. Army Corps of Engineers water resources programs
- U.S. EPA programs not listed above

- Councils of Governments (COGs)
- Connecticut Conference of Municipalities (CCM), Council of Small Towns (COST), etc.
- Watershed associations
- Connecticut legislature
- PEW, Public Health and other local, state and national foundations
- EPA, CDC, HUD, USDA
- Local health departments
- Local Commission Associations and other professional organizations
- CT Section AWWA, CAWPCA, etc.

Consensus Building and Communication

- Utilize OPM for high-level budgeting and funding discussions
- Query agencies for ideas about allocating resources for Plan implementation
- Summary of Action Items for WPC
    - The WPC could form a permanent committee to address funding, who could in part review and pursue traditional and untraditional funding sources.
    - The WPC can consider beginning with the identification of agencies, departments, committees that should be responsible for administration and/or execution of recommendations.
    - On a parallel track, the WPC could review existing funding programs and partnerships listed above.

5.3.2.7 Future Class B Water for Non-Potable Uses

Purpose and Background

The pathway should identify methods to encourage the use of Class B waters for non-potable uses, with the goal to reduce withdrawals from Class A waters or from systems that use Class A waters. Class A water are to be reserved for human consumption and potable use. Note that this pathway complements the policy recommendation for Class B Water for Non-Potable Uses.

Information Needs

- Review current non-potable uses of water by individual types of users (irrigation, boiler makeup water) to determine if use of Class B water could be an environmentally prudent and cost-effective alternative for other users and/or other types of users. Develop case-studies of the existing users of non-potable water to compare and consider future uses, with considerations for source proximity, reliability, cost of infrastructure and treatment, and suitability of water quality for the ultimate intended use.

Possible Partnerships

- Connecticut Siting Council
- Connecticut DEEP
- Connecticut DPH
- PURA
- OPM
- Private sector industries, power generation, agriculture, and golf

Consensus Building and Communication

- Discuss potential review process with stakeholders (golf courses, energy production, industry, wastewater operators, etc.)
- Coordinate with State C&D Plan
- Construct guidance document to outline procedures that regulatory agencies should follow to make Class B recommendations on a proposal.

Summary of Action Items for WPC

- The WPC can consider policy recommendations such as for the Siting Council, when evaluating sites for future power generation, give priority to sites with abundant Class B water nearby.
- The WPC could prepare a template for review of Class B waters for non-potable uses. The template should include a framework for evaluating source reliability, infrastructure cost, operating/treatment costs, and any regulatory requirements that may either facilitate or inhibit the conversion to, or use of, Class B water for individual non-potable uses.
- If regulatory requirements are identified that inhibit conversion of a non-potable use from the use of potable supply to use of Class B water, the WPC can consider exploring whether these regulations should be modified.

5.3.2.8 Statewide Drought Planning

Purpose and Background

Identify methods for encouragement of long-term water conservation activities, coordinated drought planning by utilities, and model ordinances for municipalities that support statewide drought planning. Note that this pathway complements the policy recommendation for Water Conservation.

Information Needs

- State Drought Plan and supporting documentation
- Existing ordinances from municipalities

Possible Partnerships

- Interagency Drought Workgroup
- CWWA / CT AWWA
- Local health departments
- Local commissions and associations
- Western, Central, and Eastern WUCCs
- UConn, the Connecticut Institute of Water Resources (CIWR)
- Councils of Governments (COGs) for assistance in local adoption.
- Connecticut Conference of Municipalities (CCM), Council of Small Towns (COST), etc.
- Federal Stakeholders – NOAA and USGS
- Watershed associations
- State's major water suppliers

Consensus Building and Communication

- Work with stakeholders to refine the Drought Plan as needed to ensure effective implementation and state oversight.
- Ensure consistency with other state planning goals, such as prioritization of water use.
- Consider recommending model ordinances for municipalities

Summary of Action Items for WPC

- Priorities for action items should be identified.
- The WPC could approve the State Drought Plan.

- The WPC, through its committees, could develop a template for interpreting statewide drought indices to local risk levels and response measures for use by utilities at the local level, based on storage, demand levels, type of system, etc.
- The WPC could provide training that supports local regulatory efforts to enforce water conservation measures.
- The WPC can consider studying the benefits and costs of implementation of drought period surcharges to encourage conservation during drought trigger stages.

5.3.2.9 Wastewater and Water Reuse

Purpose and Background

The following recommended steps are intended to clarify the environmental requirements for assimilating wastewater into waterways in Connecticut, and to help clarify opportunities for wastewater reuse for non-potable water needs. This is an important topic as a basis of understanding regional water availability and potential impacts to drinking water development.

Information Needs

- **Report on UCONN Reuse Experience:** The Science and Technical Subcommittee is preparing notes on the experience at UCONN of introducing recycled wastewater for non-potable water uses. The notes could be compiled into a guidance document that can help other institutions, corporations, municipalities, etc. determine if this is a viable technology in other locations:
  - Original Impetus – Define the need.
  - Other alternatives that were evaluated to meet the need.
  - Advantages and Disadvantages of recycled wastewater at UCONN
  - Results: Costs, Beneficial offsets to potable water, Public Acceptance, etc.
  - Lessons Learned
- Total maximum daily load (TMDL) studies have been completed and are available on DEEP and EPA websites. In addition, DEEP's 305b/303d report updates planning targets every 2 years. Assimilative capacity is documented in each NPDES permit and is based on the 7Q10 flow. Future efforts could include the Science and Technical Subcommittee and/or other groups compare assimilative flow needs to ecological flow needs.

Possible Partnerships

- The Water Planning Council could consult with UCONN and the Mashantucket Pequot Nation on lessons learned from its experience with recycled wastewater, so that it can advocate for other applications as appropriate and educate decision makers on the advantages and disadvantages. A good start would be a forum during a regular WPC meeting.

Consensus Building and Communication

- Wastewater and water reuse are broad issue that will likely be addressed outside of the Water Planning Council. The Council should work with other groups as applicable to monitor new data and information.
- Centralized and decentralized sewage systems are also a broader issue, and the Water Planning Council should work with other groups as appropriate to understand advantages and disadvantages, along with how either systems may affect water planning.

5.3.2.10 Water Use Accounting

Purpose and Background

Identify methods for tracking water usage in the state in order to support ongoing planning efforts. Note this complements the policy recommendations for Data Needs, Agricultural Practices, and Water Conservation.

Information Needs

- Data related to usage by registered diversions.
- Data related to usage by water users that do not use more than 50,000 gallons per day or do not serve more than 1,000 people, such as small community and noncommunity public water systems.
- Method for estimating and updating private water usage.
- Data related to unaccounted for water usage.

Possible Partnerships

- DEEP for usage by registered diversions and permitted diversions
- DPH for public water system usage / unaccounted for water
- PURA for public water system usage / unaccounted for water
- Western, Central, and Eastern WUCCs
- CWWA
- Growers associations for nurseries, etc.
- Golf course associations for golf course usage
- Agricultural associations for ag usage
- Industry associations and groups for their respective water users

Consensus Building and Communication

- Determine cost-effective method to update water usage information annually.
- Determine cost-effective method to update basin analysis information for planning purposes.

Summary of Action Items for WPC

- The WPC can consider recommending methods to facilitate reporting of small water system usage.
- The WPC could identify a state agency to conduct estimation of private water usage for planning purposes.
- The WPC could request large public water systems to track unaccounted for water use on an annual basis, through the use of AWWA audit programs and the PURA annual reporting

forms, and report to the WPC. The WPC could consider a requirement for annual reporting of water usage to PURA for all utilities above a certain threshold (possibly including those utilities that are not currently reporting to PURA).

- The WPC can consider recommending a state agency to consolidate disparate water usage data into from each agency into a single report which can be used to support future planning efforts.

5.3.2.11 Instream Flow: Ecological Flows and Stream Flow Standards and Regulations

[Note that this Section 5.3.2.11 has been updated based on input received in June 2017 from the Steering Committee and the Policy Subcommittee, and therefore discussion regarding initial steps forward on this topic, possibly more so than other Pathways Forward, may need to be continued as part of consensus building.]

Purpose and Background

Instream and out-of-stream uses of water are both legitimate water needs. Instream needs are currently defined in two ways: First, many reservoirs are currently required or will be required, either by permit, riparian agreement, flow management plan, or by the Stream Flow Regulations, to release water downstream of dams in order to preserve streamflow. It has been acknowledged by stakeholders that these required flows represent localized improvement of ecological conditions, but not necessarily flows that would enhance or sustain aquatic habitat throughout the entirety of each basin. To help quantify this need, the Plan has estimated for planning purposes a broader range of desired instream flow levels basin wide, using the same criteria for fish life cycles as those used to establish localized reservoir releases. For the purposes of this document, these are referred to as "Desired Ecological Flows" for an entire basin, of which the regulatory mandates for reservoir releases are a component.

Of note are off-ramps/allowable exceptions that apply due to drought triggers or margin of safety triggers that address water availability during times of hydrologic stress.

The purpose, then, of the following suggested next steps is to better understand the impacts of regulatory releases as well as the broader ecological flows, and to begin the discussion about how to balance both the uses of water for instream and out-of-stream needs, as well as balancing cutbacks or reductions in times of drought.

Information Needs

- Minimum Stream Flow Regulations will have impacts on current and future safe yield for public drinking water supply, and may impact available water as well. It is understood that impacts to safe yield and Margin of Safety will be reservoir system specific, and in some cases, may require replacement supplies and/or enhanced conservation. These impacts are being calculated by some water utilities and may be reported as part of the Water Utility Coordinating Committee (WUCC) process, while other water utilities are conducting analysis when individual water supply plans are updated; either way, the information should be incorporated into implementation decisions for the Plan.
- It is recommended that the WPC assess the effects (financial and otherwise) of regulatory reservoir releases to water utilities, recreation, and others in accordance with the "triple bottom line" approach described earlier.
- It is recommended that although the ecological flow targets presented in this report are not regulatory mandates (unlike the required reservoir releases, which are just a component of the total desired ecological flow for a basin), the impacts of satisfying these needs to the greatest extent possible be included in evaluation of the impacts of the Stream Flow Standards on water utilities, with respect to yield, margin of safety, and cost.

- Likewise, it is advisable to better understand the actual water needs of the ecosystem and the potential flexibility in the ecological flow targets, knowing that they cannot (and have not) always been met historically, but that such unmet needs may result in impaired fish populations.
- It could be useful to extend the work of this study and quantify (or estimate) the amount of basin-wide ecological flow that occurs in headwater streams (typically Class A), to better understand the potential impacts on and roles of these sensitive areas in satisfying a river system's flow targets as well as the benefits and consequences of consideration these resources for future water supply.
- Building on the recommendations in Section 5.3.2.5 (Economic Impacts), economic benefits of ecological flows could be defined, both in terms of recreational and environmental value, but also from a quality of life viewpoint.

Possible Partnerships

- The WPC could consider partnerships with environmental advocacy groups, water utilities, businesses, municipalities and/or other key groups to hold forums to discuss the fact that desired ecological flows on a basin-wide basis may not always be satisfied (even under natural conditions) during periods of drought, and to begin conversations about balancing expectations for both instream targets and out-of-stream withdrawals during droughts. Currently, water withdrawals are allowed by permits or registrations up to the permitted or registered amount, and certain reservoir releases are required by the Stream Flow Standards, but the basin-wide ecological flow ranges presented in this report are currently not governed by law or by regulation, though this does not imply that they should not be considered in the overall balance of flow needs throughout the hydrologic spectrum.
- Consider partnership with aquatic biology department at a New England university to better understand the flow thresholds adopted for ecological flow ranges presented in this report (above and beyond the required reservoir releases, but statistically based on the same historical flow patterns, and varying for different periods in the life cycle of fish species). The need for ecological flow, the effects of not sustaining it in any year or in just some years, as well as potential flexibility in such flows, can add exceptional clarity to decision making on the balance of future water uses.
- Consider partnerships with recreation-oriented businesses and organizations to compile information about economic benefits of adequate instream flows.

Consensus Building and Communication

- The WPC should include in its outreach program (see Outreach Policy Recommendations) the following points:
  - In times of plenty, both instream and out-of-stream needs can likely be satisfied in most places in the state.
  - During times of drought or even during typical summer conditions, there may not be sufficient water in some basins to fully satisfy both needs, and any measures taken should be balanced just as the legitimacy of both needs is also balanced. In other words, water conservation measures for out-of-stream uses should not be the only measures taken

during times of basin stress, as excessive restrictions could affect human health, local economies, etc.

- Class B water for non-potable uses should be considered where it can be administered reliably and cost-effectively. Class B waters are generally less susceptible to imbalances between instream and out-of-stream uses because these competing needs are concentrated most heavily on Class A headwater streams, which are more vulnerable naturally due to lower flow levels in headwater areas.
- Opportunities for enhancing savings through conservation should be explored and advocated through the state water plan, not just for times of drought, but to increase available supply throughout the state. Long term measures may include promoting landscape and built design standards, along with public education about water conservation. It will be important to have appropriate enforcement tools, during times of drought or other water shortages, to enforce any mandated restrictions, whether through local drought ordnances and/or broader powers through state legislation.

Other Pathways Grouped by Theme

This final group of Pathways forward are less specific, and are offered for consideration and guidance mostly as cases arise that could benefit from additional work. These include Overcoming Future Challenges, and Technology issues, neither of which needs a specific statewide policy or specific next steps. Rather, we offer suggestions for how to better understand and consider these issues in the future. Much of this information supplements information in the earlier white papers, and reflects numerous discussions at the committee level. Also included in this section are Private Wells, since it was determined during latter stages of Phase II.

5.3.2.12 Overcoming Future Challenges

Purpose and Background

White Paper #4 explained the numerous challenges that may pose barriers to implementing new water management strategies in the future. Some of these challenges have been addressed with specific policy recommendations, or with acknowledgments that they are unchangeable aspects of Connecticut governance, established for the overall common good. Others, whose future may be more ambiguous, have been addressed below with general recommendations on how the WPC might consider these challenges and barriers in the years ahead.

This paper is organized differently than some of the other high-priority next steps. Rather than specific fact-finding and consensus-building activities, the suggestions below are generalized to create awareness within the WPC and its stakeholders on how these issues could be addressed.

Changes to Laws and Regulations

While this Plan does not create new laws or regulations, it has developed a series of policy recommendations which should help establish uniform guiding principles for future legislation and regulatory updates. Additionally, as the WPC oversees the implementation of the Plan by helping to usher recommended policies through the legislature and initiating next steps to help bring unresolved issues closer to closure, its regular public meetings should offer a consistent forum for debating and reconciling recommended changes to future laws and regulations.

Levels of Authority for Implementation

The Plan (in a separate section) has recommended a procedure with which the WPC will oversee the implementation of the Plan in at least two important ways:

- Endorse the policy recommendations to the legislature,
- Usher the unresolved issues through prescribed steps of fact-finding, partnering, and consensus-building, referred to herein as "Pathways Forward." A formal process for this has been outlined in Section 5.5.2 of this document. At any point in the process, the WPC may rely upon guidance from a proposed "Implementation Advisory Group," effectively an extension of the current WPCAG with an adapted charter, or may determine on its own (in public hearings) to make recommendations directly to the legislature.

The Water Planning Council does not have statutory authority to establish laws, but will be in the position to recommend such to the legislature based on the policies formulated in the Plan and with

the Plan's help. In such a capacity, it is recommended that the WPC strive for consensus in its recommendations to the legislature, but where this is not achievable, to share with the legislature the alternative views of the WPC members, so that informed decisions can be made. Consensus-backed decisions are the most defensible, but well-informed decisions can still be made by sharing the range of viewpoints within the WPC. In other words, this Plan encourages the WPC to make recommendations to the legislature with or without consensus of its four members, and to recognize that opposing points of view, well-articulated, can often be the basis of the most solid decisions.

The Plan does NOT recommend changes in authority for regulatory agencies in Connecticut, nor does the Plan attempt to alter or usurp existing statutory authorities, permitting processes, or oversight responsibilities. Rather, the Plan is offered as guidance for collaborative decision making and the continuing formulation of consensus-based principles for future laws and regulations.

Watershed and Aquifer Protection where Incentives are Lacking

While the state has several programs in place to protect public water supply watersheds and aquifers, some surface waters and aquifers are less protected. One concern is that headwater streams may not have or will begin to lose existing strong protections if they cannot be viably used for public water supply. Without protection for the purpose of public water supply watershed protection, other tools may be needed to protect these rural headwaters regions of the state. The WPC should review at least once every five years the status of small headwaters streams that may be at risk due to loss of automatic protections afforded by status as a public water supply.

The State Aquifer Protection Program has provided protection for the state's most important public water supply stratified drift aquifers, but is not designed to protect aquifers that are not used for public water supply. The Connecticut State Water Quality Standards set goals and standards for groundwater quality in Class GA and GB areas. Municipalities in Connecticut are entitled to protect aquifer systems through other means, such as separate sets of regulations. However, many municipalities do not maintain separate sets of regulations for their sand and gravel or bedrock aquifers. The WPC should determine whether there is a need to incentivize (monetarily or otherwise) additional aquifer protections, noting that contaminants of emerging concern are not only associated with treated wastewater, but with roadway runoff and runoff containing pesticides and fertilizers.

Finally, DPH has recognized that existing watershed protection programs of DEEP do not typically apply to public water supply watersheds because the streams are not impaired. The Drinking Water Quality Management Plan (DWQMP) was conceptually developed and tested in southeastern Connecticut as a tool for additional protections.

Vulnerability and Security Issues

The need for access to information to conduct effective statewide water planning must be balanced against the need to maintain water system security. From time to time, WPC has participated in the development and/or support of legislative actions (proposed bills) to help achieve this balance. The WPC should consider supporting legislative bills which meet the stated purpose of achieving this balance.

Food-Energy-Water Nexus

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food: to pump water from groundwater or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods.

Agriculture is currently the largest user of water at the global level, accounting for 70% of total withdrawal. The food production and supply chain accounts for about 30% of total global energy consumption. In Connecticut, agricultural water use represents a much lower fraction of total water use, but it still constitutes an important use of water.

There are many synergies and trade-offs between water and energy use and food production. Using water to irrigate crops might promote food production but it can also reduce river flows and hydropower potential. Growing bioenergy crops under irrigated agriculture can increase overall water withdrawals and jeopardize food security. Converting surface irrigation into high efficiency pressurized irrigation may save water but may also result in higher energy use. Recognizing and communicating these synergies and balancing these trade-offs is central to jointly ensuring water, energy and food security.

Emerging Contaminants

"Emerging contaminants" can be broadly defined as any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and(or) human health effects. In some cases, release of emerging chemical or microbial contaminants to the environment has likely occurred for a long time, but may not have been recognized until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging contaminants.

Research is documenting with increasing frequency that many chemical and microbial constituents that have not historically been considered as contaminants are present in the environment on a global scale. These "emerging contaminants" or "contaminants of emerging concern" are commonly derived from municipal, agricultural, and industrial wastewater sources and pathways. These newly recognized contaminants represent a shift in traditional thinking as many are produced industrially yet are dispersed to the environment from domestic, commercial, and industrial uses. In addition, air deposition of various contaminants is a statewide water quality concern.

Because the State of Connecticut restricts the discharge of wastewater to drinking water supply systems, emerging contaminants are not likely as high a concern here as they are in other states that derive drinking water from sources that also receive treated wastewater. However, because of the close proximity of some well fields in the state to Class B river reaches, further study may be warranted. The WPC and DPH may wish to develop a testing program for such well fields to determine if there are consistent readings and/or trends for detectable toxic, biological or pharmaceutical contaminants in groundwater in close proximity to Class B waterways. The testing could be conducted as part of the existing GWUDI testing protocol for new wells.

Constraints on System Expansion

The challenges associated with sewer system expansion in Connecticut are inconsistency with state, regional, and local plans; local opposition due to perceived induced development; inability to secure state funding when the action is contrary to the State C&D Plan to the point that the inconsistency cannot be resolved; and lack of funding in general. In contrast, the challenges associated with water system expansion in Connecticut are fewer, and mainly related to lack of discretionary funding available from the public, regional, or private water utility. However, state-funded extension of public water must be consistent with the State C&D Plan and bring with it the same challenges regarding potential induced growth. While there do not appear to be vast areas of water or sewer need at this time, it is likely that expansion needs will materialize in the future. The WPC should monitor future needs and ensure that they can be met appropriately.

Climate Change

Climate change alone is not necessarily a specific risk to water in Connecticut, but its impacts should be understood in order to prioritize initiatives and help ensure sustainable resources. In other sections of this plan, the potential impacts of future changes in precipitation and air temperature are examined with respect to the availability of water in each basin to satisfy out-of-stream and instream demands. Several policy recommendations have been included to help offset potential risks to availability of water, including conservation initiatives, exploration of Class B water use for non-potable uses, etc.

The Plan does not specifically address potential increases in flood potential or sea level rise, though such factors are explored in other studies of northeast states and Connecticut in particular. Several good references for a wide range of potential impacts include:

- Connecticut Institute for Resilience & Climate Adaptation (CIRCA)
- Climate Change Connecticut. 2010. "The Impacts of Climate change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health" A Report by the Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf

The WPC could sponsor forums or workshops as part of its regular meetings that discuss the relative risk of climate change impacts in the balance with other issues in Connecticut, in order to help prioritize initiatives. This may be particularly important along the coast, as coastal flooding and salt water intrusion may emerge as some of the most distinct risks.

The WPC could also seek to have technical results included in this Plan combined with results from other studies (such as mentioned above) to formulate adaptation guidelines, which would help municipalities and utilities assess local risks, since it is unlikely that one universal policy on climate change adaptation would be applicable statewide. This could be formatted to help quantify the potential local changes in: precipitation; temperature; fresh water availability; sea level rise and flood frequency and/or intensity, and then estimate the potential impacts that these changes might have on resources, facilities, and other infrastructure. A methodical approach will help prioritize adaptation measures cost-effectively by targeting the resources or facilities at greatest risk.

The WPC could also consider the following "best management practices" for climate change adaptation, measures which are often beneficial for other reasons but have multiple benefits

because of the protections they offer against an uncertain climate. These measures are often referred to as "no-regret" measures because they either represent small investments for verifiable protection, or because they are already in progress or incentivized (monetarily or otherwise) through other initiatives and do not represent an add-on cost. For example, the WPC could encourage the following:

- Localize drought response plans based on the State Drought Plan (individualized triggers for conservation, emergency supplies, interconnections, etc.)
- Green infrastructure, which can help augment low flows, reduce high flows, reduce erosion, and improve water quality
- Climate trend tracking at the state level, such that specific future investments can be made at the right time in response to actual climate trends rather than projections.

Initiatives such as these could potentially be incentivized (monetarily or otherwise) by the state, and publicized and coordinated with the help of the WPC.

5.3.2.13 Technology Issues

Purpose and Background

Review the following technologies: Electronic Data Collection, Technology and Facility Improvements, Water Reuse and Greywater, Wastewater Management, Stormwater Management, Desalination, Flood Management

Information Needs

- Electronic Data Collection- Identify which systems need to transition to electronic data reporting and provide financial or other incentives necessary
- Technology and Facility Improvements- identify where these are needed in the state
- Water Reuse and Greywater- determine if this technology can be expanded from the two facilities and if there is a need
- Wastewater Management- identify advanced wastewater treatment that will be needed to achieve future regulatory compliance
- Stormwater Management- Evaluate stormwater harvesting as a water supply measure
- Desalination-Evaluate future desalination as a future water supply for coastal areas
- Flood Management- Flood management opportunities for water supply (skimming) are limited due to the Class A water requirement for surface waters used for drinking (many flood skimming opportunities are presumably on Class B waters). However, more detailed flood protection and mitigation studies may be needed to prioritize funding for coastal as well as inland communities.

Possible Partnerships

- CWWA and state agencies (DPH and DEEP)
- Partnership with Alliance for Water Efficiency
- Work with utilities on outreach/education
- Link with interconnection planning on a case-by-case basis
- Link to “Sustainable CT” initiative
- Partner with universities

Consensus Building and Communication

- Statewide consistency with other plans
- Coordinate with WUCC
- Coordinate with DPH and DEEP
- Encourage green infrastructure to reduce dependence on water for landscaping and other outdoor needs (use examples in CT – United Technologies, Coke …)
- Work with appropriate groups

5.3.2.14 Private Wells

Purpose and Background

The Plan addresses private water supply wells (private wells) in several discussions:

- The white papers note that private wells that supply residential properties for domestic use and many small non-residential properties are not regulated by the EPA, and likewise are not regulated by the DPH's Drinking Water Section. Private well owners are responsible for testing the quality of their own drinking water and maintaining their own wells. Private wells are initially tested when a well is first constructed for basic parameters and may not be tested for several years thereafter. Private wells are typically tested during the home inspection of a real estate transaction or when required by a mortgage company. Testing of private wells since 2013 for metals such as arsenic and uranium that were not likely included in the basic testing of a private well prior to this timeframe has resulted in the identification of areas of the state with very high levels of these naturally occurring contaminants. Well yield and well construction data is not available in one location, but can be found on thousands of drillers' logs filed with the Department of Consumer Protection.
- Chapter 2 notes that well drillers have been filing these permits and completion reports since the 1970s; and the reports were scanned between 2000 and 2010 and are now available as images, filed by town and year.
- Section 5.1 recommends the implementation of a water quality testing and reporting program for private wells with automatic reporting to DPH and local health districts. Connecticut General Statutes Section 19a-37 subsection (b) requires submittal of water quality test results to DPH and the local health department when testing is done for a real estate transaction, but it may be valuable to consider more frequent/periodic testing. Ideally, it would be useful to implement a water volume metering or monitoring program for private wells, but this may be impractical. One way to improve private well data would be to establish laws or regulations that require information on the capacity of the pump installed in the water supply well be reported and maintained in the statewide database for all water supply wells (both existing and future). The database would have all the same information about a water supply well that is currently provided on the paper well completion reports filed by a well drilling contractor, and would represent an upper limit on total private well capacity in the state. It would be important to recognize that capacity is usually a poor indicator of actual usage, because private wells are typically not pumping continuously, but it would be a step toward better centralized data on total private well capacity in the state.
- Section 5.2.3.1 (Policy Recommendation for Land Use Practices and Protection Related to Water) suggests that the state's private well program could be empowered to provide additional tools, training, and best practices for protection of private wells through local health districts and/or directly.
- Section 5.2.3.12 (Policy Recommendation for Data, under "Private Well Records") notes that drillers' logs are collected and filed by the Department of Consumer Protection and exist as paper copies and PDFs. Going forward, the information on drillers' logs (location of well, type, depth, diameter, yield, static water level, key geologic information) should be entered into a database to be maintained by the Department of Consumer Protection and/or another agency. As resources permit, existing logs should be entered into the database.

Information Needs

- According to the DPH, approximately 322,578 private residential wells in Connecticut serve approximately 23% of the state's population. These figures are based on several assumptions and, while believed reasonable, a more precise estimate would be preferred. A combination of GIS-based tools such as detailed public water system mapping, census tract and block data, and local health district records could be used to refine these figures.

  Note that electronic forms for well logs are available and that the WPC may work with the Department of Consumer Protection to adopt an electronic form for submission of well logs to begin creating a database.

- With reference to the Policy Recommendation for Data, going forward, the information on drillers' logs (location of well, type, depth, diameter, yield, static water level, key geologic information) should be entered into a database to be maintained by the Department of Consumer Protection and/or another agency. Accurate GPS coordinates should be obtained and uploaded to this database upon completion of the well and issuance of the drillers' log.

- With reference to the Policy Recommendation for Data, looking backward, information on drillers' logs should be entered into a database. Because the locational information on existing drillers' logs is not precise, the database should not attempt to assign a specific precise location for each well. Instead, municipalities could be gridded and a grid cell could be selected as the location. This would allow aggregation or disaggregation later.

- Previous attempts (successful or otherwise) to catalog private wells records should be obtained and used either as a starting point or an example of what worked or did not work in these attempts to catalog private wells.

- With reference to the Section 5.1 recommendation for the implementation of a water quality testing and reporting program, a statewide pilot program could be tested initially to gauge methods of gathering existing water quality data that are already collected in connection with real estate transactions and other existing testing programs.

Possible Partnerships

- The Department of Consumer Protection is a critical partner in any efforts involving private wells, as this agency regulates drillers.

- The DPH Private Well Program and the local health districts are also critical partners, since they possess much of the background data about private wells.

- The University of Connecticut may be a partner for its private well studies, such as those conducted by Dr. Gary Robbins.

- The USGS may be a partner for private its well studies that have been conducted.

- The DEEP may be partner for its interests related to groundwater quality.

- Homebuilding and real estate associations are key partners for buy-in and compliance with any new regulations.

- Laboratories are key partners for compliance with any future testing requirements.

Consensus Building and Communication

- The Department of Consumer Protection and well drillers should be invited to join the discussions regarding private well locations and information.
- Homebuilders, real estate associations, and laboratories should be invited to join the discussions regarding private well testing and water quality reporting.
- The WPC or its designee should work with DPH and DEEP and the other partners described in this pathway forward to work out potential challenges prior to initiating legislation.

5.4 Water Issues Addressed by Other Plans or Initiatives

During the planning process, stakeholders agreed that the following issues were being addressed by other statewide initiatives, and that the Plan should not duplicate efforts. Some of these, however, are associated with related issues for which there are recommendations or pathways included in either Section 5.2 or 5.3 of this report.

- **Registered Diversions**: Permitted and registered water diversions are considered by law to reflect current legal rights to use water (not to be confused with "owning" water, as is suggested by western water rights) up to the allowable amount. This Plan does make recommendations for reducing the total volume of registered diversions by removing obsolete or unused registrations from the record.
- **Stream Flow Standards**: The Plan acknowledges that the Stream Flow Standards promulgated by DEEP are being implemented throughout the state now and in coming years, and does not attempt to change direction on this issue. Instead, the Plan provides information on how these standards affect total water need in each basin, and also how they represent just a portion of scientifically desirable instream flow conditions for aquatic ecology.
- **State Drought Plan:** The Water Planning Council Advisory Group Drought Workgroup has developed a statewide drought plan that is currently under review and consideration for adoption. The State Water Plan makes no attempt to duplicate or alter this effort. Rather, the State Water Plan recommends steps in Section 5.3 to help translate statewide drought indications into local response plans.
- **Coastal Flood Planning:** While the State Water Plan addresses the potential impacts of climate change on river basin hydrology, and also offers suggested next steps for climate adaptation (Section 5.3), it does not address coastal resiliency to climate change because many other initiatives have addressed (or are addressing) this issue:
  - The CT Hazard Mitigation Plan (2014) addresses climate change and sea level rise; the update (beginning soon) will continue to address them.
  - All coastal single jurisdiction and multi-jurisdiction hazard mitigation plans address sea level rise and coastal flooding.
  - Individual coastal resilience plans are done or almost done for:
    - *Stratford*
    - *Milford*
    - *West Haven*
    - *Branford*
    - *Guilford*
    - *Madison*
    - *Old Saybrook*
    - *Waterford*
    - *Groton*

- *Stonington*

- The Towns of Fairfield through Madison (ten towns) participated in the "Regional Framework for Coastal Resilience" plan and design contract.
- Hurricane Sandy appropriations have funded numerous studies, designs, and construction via HUD (CDBG-DR) along the entire CT shoreline.
- CIRCA has funded several municipal resilience studies and projects
- The Rebuild by Design (RBD) and Natural Disaster Resilience Competition (NDRC) awards to the state will fund flood protection in Bridgeport, as well as statewide resiliency planning

- **Water Quality Compliance:** DEEP has undertaken numerous studies of Total Maximum Daily Load (TMDLs), which compute allowable wasteload allocations from point source and nonpoint sources of pollution (treated wastewater effluent, stormwater runoff, industrial discharges, etc.). The State Water Plan does not attempt to replace or alter this ongoing work toward water quality compliance, which is being conducted in accordance with national standards.

5.5 Recommended Water Management Structure and Decision Framework

5.5.1 Role and Authority of the WPC

Throughout the years leading up to the formulation of this Plan, the WPC has maintained authority to oversee and direct work groups, subcommittees, and the Advisory Group in the gathering of information, formulation of issues, and the study of how other states in the U.S. have undertaken statewide water planning.

During the one-year planning process, the WPC has continued to direct these working groups, and has retained the ultimate decision authority for what information goes into the Plan, and how the language is crafted. Each member's responsibility has been to represent the interests of his or her respective agency, as well as the collective will of participating stakeholders and citizens who have spoken to the public forums.

Once the Plan has been delivered from the consultant to the WPC, and then from the WPC to the State Legislature, it is recommended that the WPC continue to enable the implementation of the Plan and its stated principles by assuming the following roles and responsibilities, or delegating responsibility to others as appropriate:

Roles:

- Create audiences with lawmakers to explain how the policy recommendations in the Plan should guide future legislation and regulations.
- Prioritize the basins in the state that would most benefit from further evaluation based on the information contained in this Plan

- Prioritize, initialize, and usher next steps (pathways) as part of Plan Implementation to the point of additional policy recommendations or changes in laws and/or regulations (see Section 5.5.2 for specific guidelines on this).
- Advocate for resources to support Plan Implementation and Next Steps (funding, agency staff, volunteers)
- Oversee Implementation of the Plan and track progress against the 17 requirements of the statute.
- Offer various alternative formats of conflict resolution, bringing to bear the information in the State Water Plan, its policy priorities, its overarching goal of establishing a balance between all uses, and the guiding principles for decision-making.
- Early review of proposed legislation related to water, especially legislation that does not originate from one of the four member agencies of the WPC. Early review would be conducted with the goal of either (a) endorsing the proposed legislation, (b) suggesting modifications that would lead to endorsement, or (c) recognizing conflicts with the Plan or with agency objectives and begin discussions earlier instead of later.
- Develop proposed legislation as necessary. Examples of potential legislation that may arise from this Plan include (but are not limited to):
  - Revoking obsolete diversion registrations
  - Water conservation laws or incentives in concert with ongoing utility initiatives
  - Private well testing program
  - Statutory authority for the Water Planning Council, as outlined above
- Consider hiring a "Water Planning Chief," who would be tasked specifically with oversight and coordination of Plan Implementation. This role would include serving as liaison between the WPC and legislature, and overseeing the execution of future steps decided upon by the WPC.

Authority:

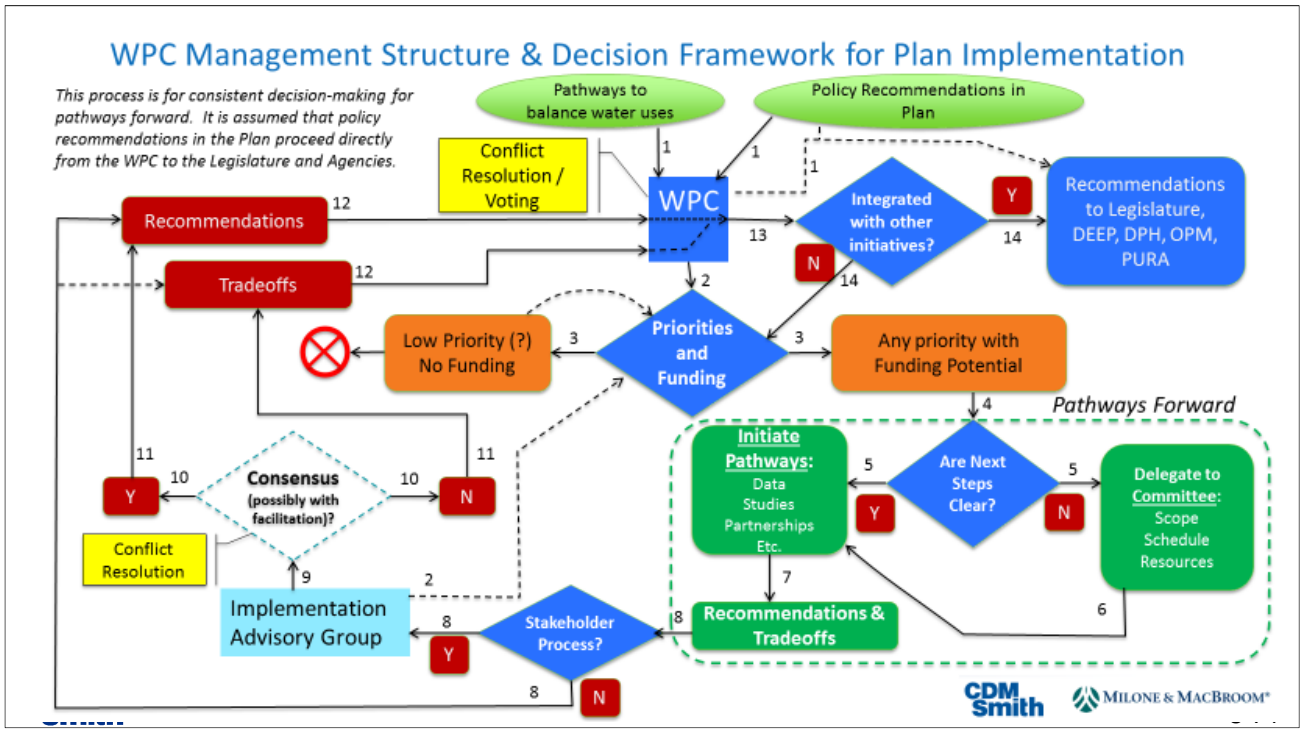
- Initialize appropriate next steps (Pathways Forward) and render decisions on how to present additional recommendations to the legislature.
- Delegate Plan implementation assignments to state agencies, the Advisory Group and other work groups and subcommittees, as appropriate.
- Consider guidance from Advisory Group and others and render decisions for legislative consideration (see Section 5.5.2 for specific process guidelines).
- Decide which cases to consider as non-binding arbiters.
- Commission volunteer basin committees as needed (see Section 6.2), provide guidance on basin planning activities that are compatible with the principles and data within the Plan, then determine approval of recommendations from the basin commissions. Noting that numerous Watershed Associations and Coalitions currently exist across the state.

- Document Implementation steps for the Plan's recommendations, or as appropriate, alternate decisions. Ensure that the Plan and each implementation step are consistent with the 17 requirements of the state statute.
- Plan for, oversee, and execute periodic updates to the Plan in accordance with Plan Recommendations (see Section 6.8).
- The WPC may consider adding a 5th non-regulatory member to avoid the potential for tie votes when making decisions. This may require enabling legislation or revisions to the statute that constitutes the WPC and its charter.

5.5.2 WPC as Advocate for Pathways Forward

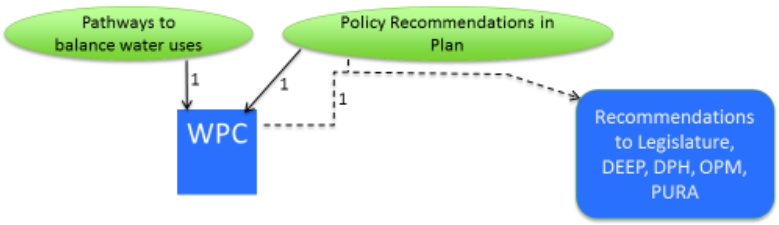
Recall from Section 5.3 that the Pathways Forward represent lists of reasonable next steps that would add clarity through information, outreach, or partnerships to issues that could not be resolved through consensus during the one-year planning process. The WPC retains its responsibility to prioritize, initiate, and usher the next steps of its choosing through a consistent process to bring the issues closer to consensus, or to draft recommendations to the legislature directly on behalf of the WPC. The process in this section is aimed at establishing a consistent basis with which the WPC can initiate, usher, and render decisions on the findings from these next steps.

The Water Planning Council will initiate next steps based on its priorities and those of its stakeholders. The following diagrams comprise **Figure 5-1** and are meant to illustrate how the WPC can shepherd a series of next steps through a consistent process that is adaptable enough to allow the WPC to convert findings into recommendations to the legislature at any point. It is expected that there will be times at which stakeholder facilitation is required to mediate discussions and debates, resolve conflicts, and identify areas of consensus. Even within the WPC, it is expected that votes will be required on certain issues. In such cases, it may be important to consider that while consensus-based recommendations to lawmakers are powerful, it can be equally effective to share all sides of a contentious issue with them, similar to a panel court decision that includes opinions both in support and in dissent of the majority decision.

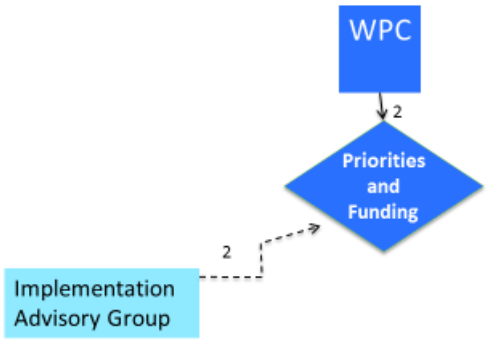


The process diagram can be summarized as follows:

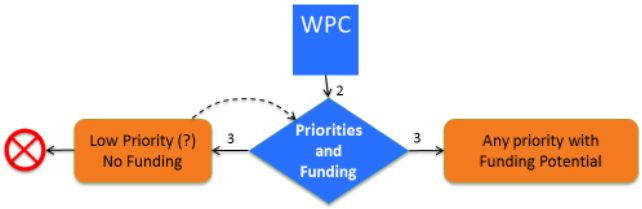
Step 1: WPC considers Policy Recommendations and Pathways Forward presented in the Plan. Generally, policy recommendations will have achieved consensus and would be passed directly on to the legislature.



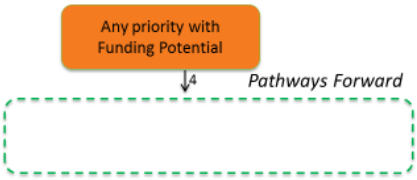
Step 2: Issues that require more time to reach consensus will be evaluated further for priorities and funding. Next steps then may be initiated. WPC will seek input from the Implementation Advisory Group, as appropriate.



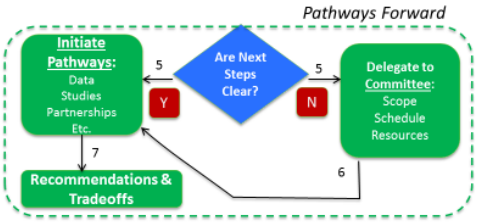
Step 3: WPC will determine priorities, perhaps using criteria such as likelihood of near term consensus, available funding, and importance to reducing clear risks. Issues deemed to have low priority or no funding will be discarded or postponed for later evaluation.



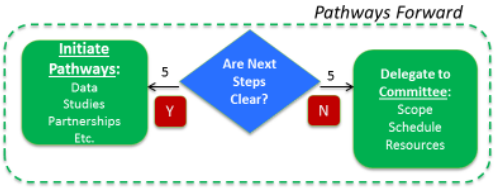
Step 4: Issues with available resources and/or high priority can be advanced to determine pathways forward.



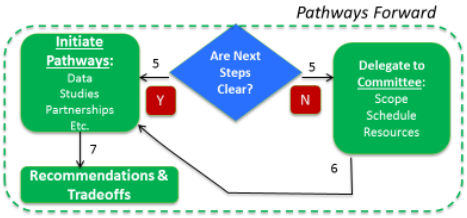
The heart of the process of determining pathways forward.



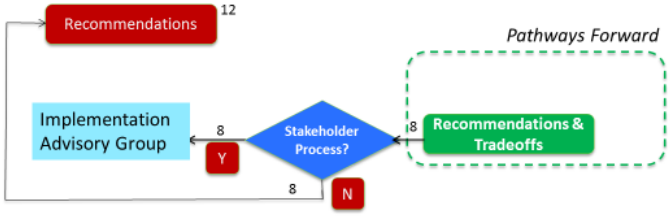
Step 5: WPC can determine if the next steps outlined in the Plan are clear and specific (as should be the case for topics presented in Sections 3.0 and 4.0 of this document) and should be initiated, and which ones require more definition (as may be the case with topics presented in Section 5.0 of this document) and should be delegated to a committee.



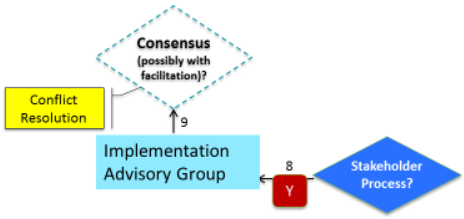
Step 6/7: If the next steps require more definition (a specific case, or the codification of general guidelines), a committee may be tasked with developing them with more specificity. The next steps (fact-finding, partnering, consensus-building) should lead to recommendations including a clearer understanding of the tradeoffs associated with any issue.



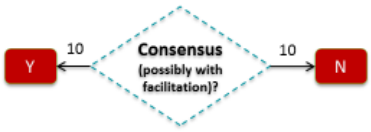
Step 8: WPC may at this time determine if a more inclusive vetting and consensus building process is warranted with stakeholders or if the recommendations are mature enough to vote on / pass to the legislature (in which case, skip to Step 12).



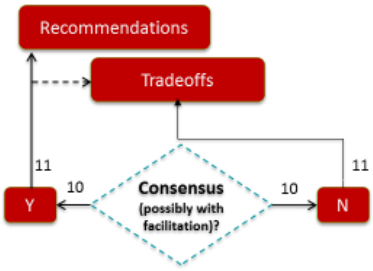
Step 9: If stakeholder consensus-building is warranted, the Implementation Advisory Group will coordinate opportunities for dialogue, debate, and conflict resolution through facilitation.



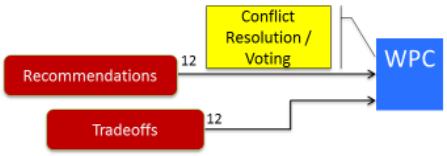
Step 10: The Implementation Advisory Group would determine if consensus has been achieved.



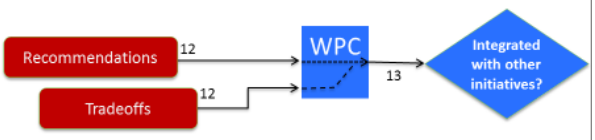
Step 11: If consensus has been achieved, the Implementation Advisory Group would develop recommendations. If consensus has not been achieved, they would articulate the various positions and the tradeoffs.



Step 12: Recommendations and/or tradeoffs are presented to the WPC for a vote on how to proceed. The discussion may be aided by conflict resolution.



Step 13: If WPC is prepared to share recommendations or opinions with the legislature, it first checks to make sure that the recommendations are compatible with other policies, initiatives, and state /regional plans.



Step 14: WPC either refines the recommendations by re-entering the process, or passes along one of two findings to the legislature: a consensus policy recommendation on the issue that was studied, or its members' various opinions about the matter, clearly explaining the tradeoffs.

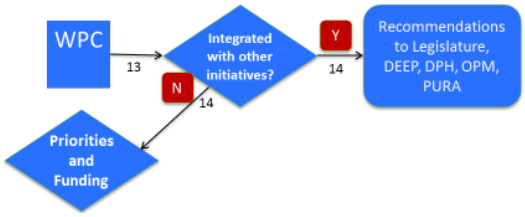


Figure 5-1. Management Framework for the WPC and Pathways Forward

5.5.3 New Roles for the WPC Advisory Group

The WPC Advisory Group, established by statute, will continue to serve after the Final Plan is complete. Some of the ways in which the Advisory Group could assist the WPC include:

- Advise the WPC on priorities for basins that need further evaluation, issues that require attention or resolution, and priorities for next steps (Pathways Forward).
- Once any Pathway Forward option is initiated, the Advisory Group may, at the discretion of the WPC, participate in discussions on interpreting findings, building consensus, and formulating recommended language for legislative consideration.
- Actively reach out to legislators, citizens, municipal officials, schools, etc. to create broad exposure to the Plan, the data it contains, and the principles upon which its recommendations are based.
- Advise the WPC on the need and utilization of volunteer basin committees (see Section 6.2). Many states commission such committees to use the information in the Plan to educate residents and officials, and to prioritize decisions within their basins – that is, to help implement the principles of a statewide plan at the local level. Many of Connecticut's basins are already represented by organized and active watershed groups, and in some cases the Councils of Government may be a useful means of translating statewide policies and information into local action. The Advisory Group could help the WPC determine if such

committees could help fill local planning gaps in basins that are not already well-represented by organized groups.

5.5.4 Plan Development Role of the Science and Technical and Policy Subcommittees

The Water Planning Council acknowledges the vital roles of these subcommittees during the Plan development. These subcommittees have been inactive or disbanded following completion of Plan development in June 2017. The WPC also acknowledges that the beneficial contributions of these committees has been due largely to the participating individuals, and not necessarily the committee structure itself. For this reason, future opportunities for engagement will likely focus more heavily on including active and engaged people than on formulating or re-formulating committee structures. Options may include expanding the roster of the Advisory Group, or establishing expert panels on technical or policy issues as needed.

5.5.5 Conflict Resolution

The Plan does not prioritize any issue over another, nor does it speak to the validity of any particular use within current state laws and regulatory guidelines. Conflicts over water use priorities will continue to arise in Connecticut; specific local water uses, new users or permittees, and equity in drought cutbacks are just several examples of ongoing debates that can recur in the future. Recently, the prospect of new water bottling facilities has been an example of such a conflict. Solutions to such conflicts are often local, and should be based on the resources, conditions, and needs using site-specific rationale. Again, the Plan does not prioritize any specific use over others, nor does it advocate for statewide controls over specific uses, which would require legislative action. However, the Plan does offer information and principles that can help resolve these conflicts, and there are many actions that the WPC can take on its own behalf in order to help resolve current and future conflicts:

- **Quantitative Framework:** The Plan clearly indicates which basins may already be overallocated, which basins may become overallocated if unused registrations are fully exercised, and which basins are likely to have available water for future permits. Furthermore, the Plan indicates how much of the water in each basin is expected to be used for out-of-stream uses, how much is required for instream uses, and the range of flow that is considered ideal for instream aquatic health. The information is supplemented by information on the amount of storage in each basin. This quantitative framework should always be consulted during a permitting process or to assist with resolving conflicts over water use and priorities, especially during periods of drought.
- **WPC as Interpreter of the Plan:** The Water Planning Council should routinely review issues and conflicts at local and statewide levels, and offer written briefs to the Legislature on how the data and principles in the Plan speak to each issue. These interpretive papers would be particularly useful if the WPC can provide opinions on behalf of the stakeholders via the continuation of the Advisory Group as well as their member agencies. In this way, the WPC can speak consistently (even if not always with full consensus) on how the Plan can assist with local conflict resolution, changes in legislation, or changes in future water regulations. Keeping the Legislature informed using the consensus-based information in the Plan will foster consistent decision-making.

- **WPC as Arbiter / Mediator:**

  The WPC, as the leading advocate for the State Water Plan, should offer its experience and interpretations of the Plan to help resolve future water conflicts or issues. Resolution could take one of three forms:

  - **WPC as Non-Binding Arbiter of Local Conflicts**: The Water Planning Council should volunteer to serve as a non-binding arbitration panel to offer opinions to regulators and/or legislators on future water conflicts as they arise. Non-binding arbitration or mediation based consistently on the Plan's consensus-based principles could help parties to future conflicts understand the context in which decisions are ultimately made, and offer the possibility of finding mutually beneficial common ground. Ultimately, the decision authority in most matters would reside with regulatory agencies or with lawmakers, but WPC involvement as an arbiter or mediator would help ensure that the principles in the Plan are applied consistently during times of deliberation.
  - **WPC as Binding Arbiter**: In some cases, it may be appropriate for the WPC to offer binding arbitration on future water issues or conflicts. This may require enabling legislation or modification to the statute that constitutes the WPC and its charter.
  - **WPC as Nominator of Mediator**: Because certain issues may involve conflicting views from the WPC member agencies, some situations may be best solved through impartial mediation. In such cases, the WPC should appoint a mediator whose nomination is approved by all four member agencies. Mediation would be undertaken with the goal of recommending a resolution to the WPC for endorsement, or if agreements can be reached entirely within the bounds of existing laws and regulations, the recommendations could proceed directly to the appropriate regulatory authorities (for permitting, etc.)

- **WPC as Advocate for Conflict Resolution through Modeling:** In Section 3.1.6, this report demonstrates how simulation modeling can be used to "zoom in" to specific areas within river basins at finer resolution than is offered by the data and analysis in this Plan. Across the United States, simulation models are used as the basis of dispute resolution if the input data and underlying assumptions are agreeable to all parties. The models can be used to answer "what-if" questions about future water management strategies, identify the sensitivity of rivers, tributaries, reservoirs, and groundwater to changes in water use patterns, and trace impacts of decisions throughout the river network. Such processes are highly collaborative, involving stakeholders during all phases of data collection, formulation, testing, and ultimately the application of the models. The WPC could serve as the facilitator for this process, recommending tools and scenarios that could help stakeholders better understand the benefits and consequences of future decisions.

Section 6

Implementation of the State Water Plan

6.1 Continued Education and Outreach

As detailed throughout the Plan, education and outreach efforts pay dividends when both preparing and upon implementation of water management decisions. The energy and passion that individuals, groups, and stakeholders have for the topic is commendable and should continue to be used to benefit Plan. The Plan was developed using a process open to the public and one that encouraged participation and input. To keep that energy working towards the Plan, those involved parties along with new participants, should be continued and expanded upon.

The following sections detail components of various types of education, outreach and participation, which will be critical to a successful implementation of the Plan.

6.2 Local Participation

In order for the Plan to be useful and beneficial, its broad statewide objectives and policies must be implemented at a local or regional level. Recommendations on outreach in Section 5.2.3.9 will help disseminate the Plan and its principles to local officials and citizens by specifically targeting local activity.

Additionally, the State could consider the establishment of Volunteer Basin Committees in basins that are not already represented by organized and active watershed groups or extensions of the Councils of Government. Many states commission such committees to use the guiding principles in their state water plans to educate residents and local officials, prioritize decisions within their own basins based on local knowledge and concerns, and to recommend specific actions back to state officials (in this case, likely the Water Planning Council) that are consistent with the plan's principles and framework. In other words, basin committees are responsible for recommending how a state water plan can or should be implemented to address the specific needs of individual basins and their stakeholders.

In Connecticut, Volunteer Basin Committees could be formed at the regional basin level (corresponding to the 44 basins delineated in this Plan), or at the larger river basin scale, such as the Housatonic, Thames, Connecticut, etc. Alternatively, since many river basins already have active and well-established advocacy groups, new volunteer committees could be established on an as-needed basis, or based on the basins deemed by the Water Planning Council to be most at risk of future or continued inability to satisfy all instream and out-of-stream needs (and which do not already have an organized group of active representatives). Some stakeholders suggested that this could also be an extended function of the Councils of Government.

Typically, volunteer committees are composed of people with a working knowledge of hydrologic issues and contemporary water management principles, and may include representatives from academia, business, environmental groups, agriculture, science, utilities, etc. Such committees could convene at regular intervals, perhaps 3 or 4 times per year, under a direct charter from the

Water Planning Council. Such a charter would define the composition of each group, its meeting requirements, and its overall goal to prioritize specific issues within a respective basin and to make appropriate recommendations related to these issues back to the Water Planning Council that are consistent with the Plan's goals, recommendations, and priorities.

In addition to enabling local participation in the implementation phases of the Plan, local committees are one of the best ways to perpetuate the influence of a state water plan on local decisions, and to help ensure a consistent basis for decisions across the state in years to come.

Such committees could likely be established under the auspices of the Water Planning Council without additional enabling legislation because the committees would not have decision-making authority over implementation (rather, they would make relevant recommendations to the WPC based on basin-specific issues informed by local people). Also, if these are volunteer committees, as they are in most examples, there would be no funding required. The WPC could interact with the committees and review recommendations from them during regular public WPC meetings.

6.3 Future Water Allocation Principles

A core principle for future water allocation is to use technical information for future decisions. Basin fact sheets and maps can help inform discussions on large users (including industry, bottlers, etc.) because these are case-by-case issues. These principles can help alleviate concern, or provide a basis for negotiation of drought cutbacks, pricing structure, and other restrictions. Models may also be a good basis of determining simulated effects of future water allocation.

6.4 Identification of Basins Which Clearly Demonstrate the Need for the Plan's Policy Recommendations

At the direction of the Water Planning Council, the Science and Technical Committee was tasked with combining technical information in this report with local knowledge of individual basins to highlight several regional basins that are good examples of the following three future risk categories, where "risk" is defined as the possibility of not satisfying all instream and out-of-stream water needs everywhere in the basin at all times, and under all conditions (it does NOT suggest that the entire basin is at risk of water depletion or impairment):

- **High risk of stress**, as indicated by the maps, storage summary, basin summary sheets, and knowledge of recent "overuse" as indicated by dry streams, for example. This could include some numeric metrics such as 50% of annual average water needed, marginal ability to satisfy all needs in typical summer, overallocated during drought, etc.
- **Tipping Point** basins can currently satisfy needs but future ability to do so is marginal to questionable based on information in the report, demand projections, and other knowledge about future changes, such as utility expansion.
- "**Pristine**" basins are able to satisfy all basin needs and currently exhibit a low risk of stress. Efforts should be made to preserve these conditions.

A screening process was implemented to evaluate all 44 of the regional basins. Maps, storage summary, basin summary sheets, and local knowledge were all used to inform the discussion. The Committee systematically evaluated each basin and decided either it belonged in one of the three previously discussed risk categories, or it could not be easily categorized on the regional basin scale. Methodically evaluating all 44 regional basins structured the conversation, and eliminated a potential bias of focusing on only the most familiar basins.

The purpose of this exercise was not to fit each of the 44 basins into one of the three risk categories. The goal was to screen all of the basins at a high level and use the basins that were easily categorized to inform a more targeted discussion to select examples for the WPC. After screening the 44 regional basins, approximately eight basins had been identified as good representatives of each of the three categories. The discussion continued in order to narrow the examples down to the most representative. Feedback from outside stakeholders, including the Rivers Alliance, and additional water quality data was considered when selecting the best examples for the WPC.

As noted elsewhere in this report, indications of future risk in any given basin are very broad at the regional scale used in this study. "Risk" refers to the possibility that certain locations (tributaries or river reaches or aquifer areas) may not be able to satisfy all needs all the time under certain conditions, but does NOT suggest that the entire basin is at risk of water depletion. The Committee reaffirmed that future work during plan implementation might focus on select sub-regional basins as necessary. Also, in addition to evaluating the 44 basins on a regional scale, there was a separate discussion where the Committee selected some local examples for the three risk categories.

Table 6-1 identifies the basins in that were identified as most representative of the three categories, and **Figure 6-1** illustrates how these are distributed across the state. A brief discussion follows.

Table 6-1. Representative Basins for Future Policy Implementation

High Risk of Not Satisfying All Current and Future Needs in All Places All the Time and Under All Conditions	Tipping Point: Basins that Currently Satisfy Needs but Demonstrate Marginal Ability to Satisfy All Future Needs	Pristine Basins in Need of Protective Measures
Southwest Western	Pomperaug	Aspetuck
Norwalk	Candlewood	Eightmile
Quinnipiac	Mattebesset	Natchaug
Quinebaug		

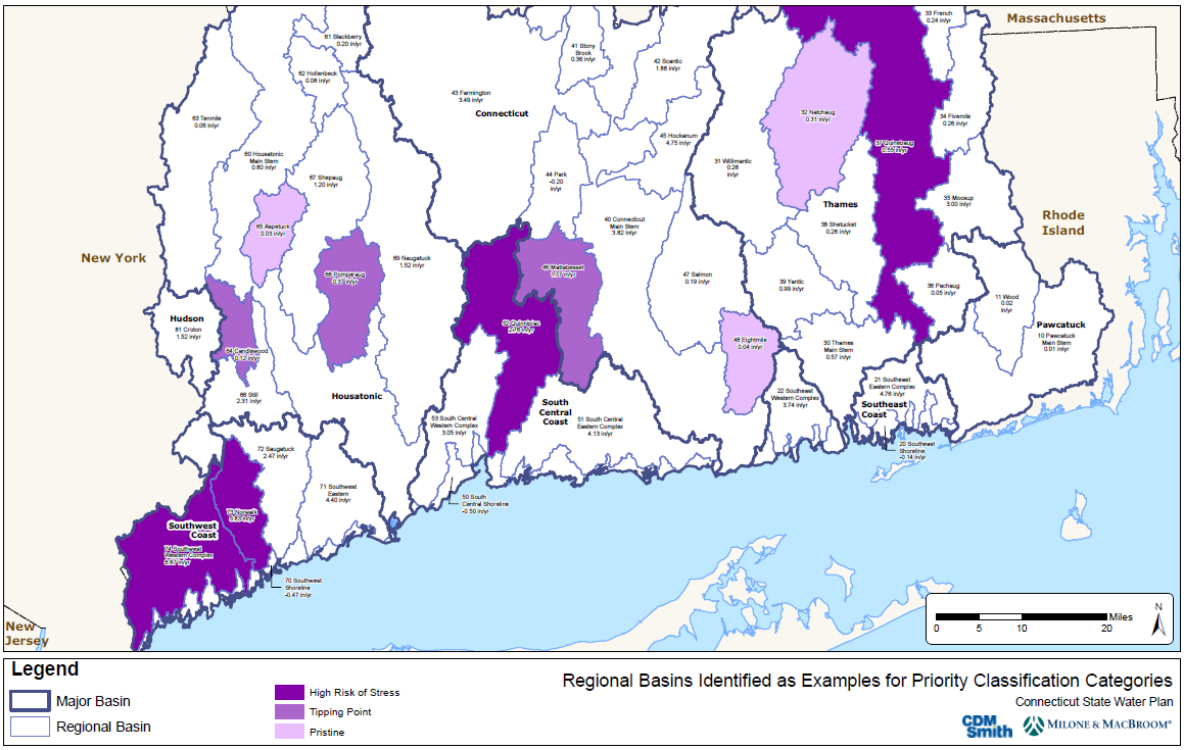


Figure 6-1. Map of Representative Basins for Future Policy Implementation

High Risk Basins: The Southwest Western Basin and the Norwalk Basin are located adjacent to each other in the Southwest corner of Connecticut. These basins are moderately developed and contain water quality impairments, stormwater impairments, and wastewater discharges. Additionally, there are complex interconnections that exist in the region. Some policy recommendations and Pathways Forward that could benefit these basins include water conservation (Section 5.2.3.3 and 5.3.2.1), streamflow regulations (Section 5.2.3.8 and 5.3.2.11) water quality improvements (Section 5.2.3.1 and 5.2.3.2), regionalization opportunities (Section 5.2.3.10), and wastewater and water reuse (Section 5.3.2.9). The other two basins characterized by high risk of not satisfying all current and future needs, the Quinnipiac and Quinebaug, may also benefit from some of these policies, and all four basins could certainly benefit from increased public awareness through outreach (Section 5.2.3.9).

"Tipping Point" Basins: The Pomperaug Basin is an example of a basin on the tipping point of change. It is currently able to satisfy all needs in the basin but documentation from USGS shows there are potential future impacts from land use change. There is extensive data collection in this area and some existing basin models to aid in future management. A policy encouraging conservation (Section 5.2.3.3) and investigating the possibility of activating an existing interconnection (Section 5.2.3.10) could help meet needs as the basin changes in the future. Candlewood Lake in the Candlewood basin is highly used for recreation as it is the largest lake in Connecticut. The lake experiences algae and cyanobacteria blooms and aquatic pesticides are sometimes used. Unique management strategies will be needed to preserve this recreational area (Section 5.2.3.2), and there might also be parties interested in using it as a drinking water supply. The Mattabesset Basin has a wide variety of land uses that includes industrial and residential.

They experience high pollutant loads and have stormwater impairments. Land use management and thoughtful development (Sections 5.2.3.1, 5.2.3.2, and 5.2.3.4) could help this basin.

"Pristine" Basins: These basins can satisfy all basin needs and currently exhibit a low risk of stress. The Eightmile basin has a wild and scenic designation and continued land use protection will be beneficial in maintaining its pristine condition (Section 5.2.3.1). The Natchaug basin was also considered to have a low risk of stress, which will be possible to maintain if there are partnerships with towns moving forward to protect land not owned by the state (Section 5.2.3.1). The Aspetuck is a basin that has successfully maintained a pristine condition through the management of agricultural practices, and could continue with the backing of the Plan (Section 5.2.3.6). It can serve as an example for what condition can be achieved in other basins through similar management practices.

Other Local Examples: At a more local level within the regional basins, examples of tributaries (sub-regional basins) that could be characterized as "high risk" and benefit from the Plan's policy recommendations include the Fenton River within the Natchaug Basin, and the Little River within the Quinebaug. The Farmington basin is an example where a more localized planning scale is required to designate risk, as its sub-regional basins cover the spectrum of the categories in this exercise. It is a large basin area with generally rural and pristine headwaters and high risk pockets in the more urban downstream areas. The Sandy Brook area was considered pristine by the Committee, while the Coppermine Brook, Pequabeck River, Still River area were all considered to be high risk. Specifically, the Coppermine Brook has experienced periods of no-flow conditions because of local groundwater pumping during droughts.

6.5 Measuring Success During Implementation

6.5.1 Tracking Against the Plan's Goals

Connecticut's water values drive Connecticut towards measurable objectives, goals, and actions. The primary goal of the Plan is to provide balanced water use for all needs.

The objectives to support this goal are included in the list below, which was developed by stakeholders using the 17 requirements in the enabling statute as guidance. The list is intended to summarize the goals, but is not necessarily inclusive of the numerous objectives embedded into the planning framework:

- Provide reliable and resilient supply for all uses
- Promote public health and quality of life with high quality water
- Protect the environment
- Manage water cost-effectively for all users
- Develop an implementable plan
- Prepare for uncertain future climate
- Use science and data to recommend action
- Involve Connecticut citizens in water management

The Plan is a living document; the Plan and the supporting work of the WPC will be updated periodically to respond to the changing conditions and improved information in the State. Part of this work will require measuring success for each action and adapting over time. Future iterations of the Plan will evaluate progress made, and identify or refine future actions.

The Plan and its goals and objectives and 17 Statutory Requirements will be tracked by the WPC or its designee to ensure implementation. The WPC may propose a planning schedule that requires a scheduled update.

The Plan portrays Connecticut's home rule, improves planning and regulatory processes, and explores funding —all while honoring Connecticut's water values and ensuring that water, the State's most valuable natural resource, is protected and available for generations to come. To that end, the Plan's success will be measured by whether the following measurable objectives are achieved through implementation of the following actions:

Provide reliable and resilient supply for all uses

The success of the Plan will ultimately be measured by whether there continues to be reliable and resilient water supply in the future. With increased efforts on conservation, land use and reuse, Connecticut can balance its water use for all needs.

Promote public health and quality of life with high quality water

Connecticut has the highest quality of source water in the nation. The continued reliance on class A water for drinking will ensure this goal is met.

Protect the environment

The environment and recreation are critical in a water plan, and have strong support in Connecticut. Strong environment is critical to the economy and way of life.

Manage water cost-effectively for all users

In order to manage water cost effectively, the State will look at funding sources for implementation of the Plan. In order to support this objective, the State should investigate options to raise additional revenue. Funds can further support conservation, water supply, environment, education and outreach, and other implementation priorities.

Connecticut, like many states, faces challenging fiscal conditions, not only for water infrastructure, but most other parts of the State budget. In order to address the water infrastructure fiscal need, the legislature can explore the use of existing grants and loans for implementation of the Plan so that the partners can achieve financing. Issuance of green bonds could support large scale environmental and recreational projects.

Develop an implementable plan

An implementable plan relies on measurable actions, to be achieved in a timely fashion. It also requires an organizational structure that can move the Plan forward with adequate funding.

Prepare for uncertain future climate

An adaptive management plan will assist in preparing for all future uncertainties, including climate change. Climate uncertainties can be taken into account in both demand and supply analysis.

Use science and data to recommend action

A data driven water plan that relies on science and data can ensure that appropriate actions are recommended and implemented.

Involve Connecticut citizens in water management

Connecticut's Plan sets out to significantly improve the level of public awareness and engagement regarding water issues statewide. The Plan will expand outreach and education efforts that engage the public to promote well-informed community discourse and decision making regarding balanced water solutions. This work will be collaborative and include state, local and federal partners.

6.5.2 Tracking Against the 17 Statutory Requirements

The State will undertake the following critical actions to make progress in achieving the measurable objectives and addressing important water priorities identified in the Plan. The referenced section further explains the context for each of the critical actions compared to the 17 Statutory Requirements. Each statutory requirement may require one or more of the following:

Legislation: Although most actions are intended to work within existing state and federal laws, some actions require state legislation. Legislative actions require the legislature to pass a bill changing language in or adding language to the Statutes. Prior to developing legislative proposals necessary to implement the Plan, the WPC and associated agencies will conduct a thorough review of what is needed. Any legislative recommendations will be evaluated in light of administration priorities and the State budget. To the extent that legislation is necessary to execute the Plan, legislative recommendations will be offered in concert with the phased implementation of the Plan over subsequent years.

Programmatic: Programmatic actions can be accomplished within existing authority and existing state programs. Some of these actions may require additional staffing or funding, which will need to be addressed prior to implementation. To that end, legislation may be needed to appropriate adequate resources.

Policy: Policy actions can be accomplished through a rule-making or other processes to give the WPC the authority to accomplish these actions. Other state agencies may also need to adopt policies, as noted below. Resources to develop and implement the policy changes will need to be identified.

Pathways Forward: Pathways Forward actions indicate actions that will involve several parties or sub-committees that develop a plan or make recommendations to the WPC or other appropriate authority. Pathways Forward actions can be accomplished within existing statutory authority. Resources to address the process actions will need to be acquired prior to implementation

The following table represents the action needed for each of the statutory requirements. Programmatic and policy actions have been handled together.

Table 6-2. Tracking Progress towards the Statutory Requirements

	17 Statutory Requirements	Programmatic /Policy	Pathways Forward
1.	Identify quantities and qualities of water that are available for public water supply, health, economic, recreation and environmental benefits on a regional basin scale (SW and GW)	X	
2.	Identify present and projected demands for water on a state-wide and regional basin scale	X	X
3.	Recommend the utilization of the state's water resources, including surface and subsurface water, [for their greatest benefits] in a manner that balances public water supply, economic development, recreation and ecological health	X	X
4.	Recommend steps to increase the climate resiliency of existing water resources and infrastructure		X
5.	Recommend technology and infrastructure upgrades, interconnections and such major engineering works or special districts which may be necessary, including the need, timing and general cost thereof	X	X
6.	Take into account desired ecological, recreational, agricultural, industrial and commercial uses	X	
7.	Inform residents of the state about the importance of water stewardship and conservation	X	X
8.	Establish guidelines and incentives for consumer water conservation	X	
9.	Develop a water reuse policy with incentives for matching the quality of the water to the use	X	X
10.	Meet data collection and analysis needs to provide for data driven water planning and permitting	X	X
11.	Take into account the ecological, environmental, public health and safety and economic impact that implementation of the state water plan will have on the state	X	
12.	Include short and long-range objectives and strategies to communicate and implement the plan	X	X
13.	Seek to incorporate regional and local plans and programs for water use and management and plans for water and sewerage facilities in the state water plan	X	
14.	Promote intra-regional solutions and sharing of water resources	X	
15.	Develop strategies to address climate resiliency including the impact of extreme weather events	X	X
16.	Identify modifications to laws and regulations needed to implement recommendation		X
17.	Take into account desired ecological, recreational, agricultural, industrial and commercial uses	X	X

Note: *Table 1-2 How the Plan Addressing the 17 Requirements* is a related component to this table's information, including tracking during Plan development.

6.6 Funding Needs and Strategies

Securing funding to enact policy recommendations and Pathways Forward is anticipated to be one of the challenges related to enacting the Plan. A variety of funding sources have been utilized to develop and enact state water planning processes across the nation. This section consolidates the disparate funding sources and techniques utilized nationwide to provide guidelines for funding implementation of Connecticut's Plan.

6.6.1 State-Level Funding Sources

State-level funding sources typically have included direct, legislatively-authorized ongoing allocations from the General Fund, redirection of staff to implementation of a state water plan (General Fund), obtaining one-time allocations from the General Fund, entering into Joint Funding Agreements with Federal Agencies, and bonding.

The General Fund

The General Fund provides funding for the state government. A variety of states have used allocations from the General Fund to fund implementation of state water plan activities. Several have used direct, one-time allocations either directly in the budget or through bonding, and others have considered alternative methods to fund activities via the General Fund. Table 6-3 presents the types of methods used in six other state water plans. Examples of funding implementation is provided following the table.

Table 6-3. Funding Methods from General Fund

State	One-Time Allocation or Specific Funding for Implementation	Redirect Staff to State Water Plan	Lottery and License Plate Revenue	Joint Funding Agreements with Federal Agencies	Annual User Fees for Water Rights and Waste Discharge Fees	Increased Sales Tax to Fund Programs
California					X	
Georgia	X					
Minnesota						X
Oregon	X		X			
Pennsylvania		X		X		
Washington	X (Bonds)					

- California's Water Resources Board has established annual user fees to fund its operations (approximately $7 million annually based on water rights and discharge (tipping) fees.
- Georgia utilized a one-time allocation from the state budget to fund regional water study updates and regional assessments.

- Minnesota changed its constitution to increase the general sales and use tax rate by 3/8 of one percentage point, with one-third of the proceeds dedicated to water quality protection, one-third to restoration of wetlands and other wildlife habitat, and one-third to support parks, arts, and cultural heritage efforts.
- Oregon primarily used state resources to fund the initial plan activities. The allocation was sold to legislators based on the value of natural resource activities to the local economy in Oregon – for every $1 invested by the General Fund in natural resource agencies, $376 in economic activity was generated in 2011. Oregon also uses lottery funding and salmon license plate revenue to fund implementation programs, and Oregon has also benefited from significant annual investments by the Bonneville Power Administration under various wildlife agreements.
- Pennsylvania noted that it changed its priorities for certain existing state workers and reassigned them to state water plan implementation. Specific funding was also allocated by State legislators to River Basin Commissions for state water plan activities, which went beyond the baseline commission funding.
- Washington used bonding to aggressively pursue the development of water supplies to benefit both instream and out-of-stream uses. One-third of the money was directly allocated to augmenting instream flows.

Successful state water plan implementation requires dedicated funding that can be distributed to various state agencies for further distribution to specific projects. It is possible that state funding from the General Fund will be an important part of implementing Connecticut's Plan. One particular issue noted in Oregon is that the loss of funding at the state level creates a cascading effect where dollars removed from the state budget result in lost matching dollars from the federal level. As natural resource agencies become increasingly more reliant on federal funds and, in some cases, lottery funds, it will become even more important to maintain state matching funds.

The Water Planning Council is encouraged to consider the alternative funding mechanisms used in other states, as well as other funding means, to secure a consistent source of funding for plan implementation. For example, Oregon is presently evaluating funding options based on four types of funding principles, including "user pays" (similar to California), "fees should be equally distributed" (similar to Minnesota), "fees should be used for the purpose for which they are collected", and "fee collection must be logistically reasonable".

State Programs

Two current examples of existing Connecticut programs that can provide funding related to Plan activities are below.

The Connecticut Institute for Resilience and Climate Adaptation (CIRCA)

CIRCA is a partnership of the University of Connecticut and the Connecticut Department of Energy and Environmental Protection. The mission of CIRCA is to assist Connecticut towns and cities to adapt to a changing climate and to enhance the resilience of their infrastructure.

Municipal Resilience Grants

CIRCA distributes grants to municipal governments and councils of government for initiatives that advance resilience, including the creation of conceptual design, construction (demonstration projects or other) of structures, or the design of practices and policies that increase their resilience to climate change and severe weather. The program is focused on implementation. Projects must review and consider integration of CIRCA's research products into proposed projects. Project grants vary from $20,000 to $200,000. Project proposals should develop knowledge or experience that is transferable to multiple locations in Connecticut and have well-defined and measurable goals. Preference is given to projects that leverage multiple funding sources and involve collaboration with CIRCA to address at least one of the following priority areas:

- Develop and deploy natural science, engineering, legal, financial, and policy best practices for climate resilience.
- Undertake or oversee pilot projects designed to improve resilience and sustainability of the natural and built environment along Connecticut's coast and inland waterways.
- Foster resilient actions and sustainable communities – particularly along the Connecticut coastline and inland waterways – that can adapt to the impacts and hazards of climate change.
- Reduce the loss of life and property, natural system and ecological damage, and social disruption from high-impact events.

Past grant awards that are aligned with topics addressed in the Plan include:

- Northwest Hills Council of Governments – Building Municipal Resilience and Climate Adaptation through Low Impact Development
- Town of Oxford - Planning for Flood Resilient and Fish-Friendly Road-Stream Crossings in the Southern Naugatuck Valley
- South Central Regional Council of Governments - Climate Adaptation and Resiliency Planning for Protection of Public Drinking Water
- Darien - Low Impact Development for Resilience Against Flooding, Storm Water, and Climate Change
- Hartford - Green Infrastructure Specialist for a More Resilient and Sustainable Future

Matching Funds Program

CIRCA will award funds to Connecticut municipalities, institutions, universities, foundations, and other non-governmental organizations for matching funds for projects that address the mission of the Institute. CIRCA matching funds are intended for grant proposals in preparation. Entities are not eligible to apply if primary funds have already been awarded. To be funded, a successful Matching Funds Request Form must have a commitment of primary funding within six months of the CIRCA award announcement, or have received a waiver from the CIRCA Executive Steering Committee. CIRCA Matching Funds will provide up to 25% of the primary funder's contribution other than municipal or State funds to enhance the likely success of project proposals that

advance CIRCA research and implementation priorities. Proposals are required to leverage independent funding awarded through a competitive process.

Project proposals should develop knowledge and/or experience that is transferable to multiple locations in Connecticut and have well-defined and measurable goals. Preference will be given to those that involve collaboration with CIRCA to address at least one of the following priority areas:

- Improve scientific understanding of the changing climate system and its local and regional impacts on coastal and inland floodplain communities;
- Develop and deploy natural science, engineering, legal, financial, and policy best practices for climate resilience;
- Undertake or oversee pilot projects designed to improve resilience and sustainability of the natural and built environment along Connecticut's coast and inland waterways;
- Create a climate-literate public that understands its vulnerabilities to a changing climate and which uses that knowledge to make scientifically informed, environmentally sound decisions;
- Foster resilient actions and sustainable communities – particularly along the Connecticut coastline and inland waterways – that can adapt to the impacts and hazards of climate change; and
- Reduce the loss of life and property, natural system and ecological damage, and social disruption from high-impact events.

Past grant awards that are aligned with topics addressed in the Plan include:

- Clean Water Fund – Execution of EASE Program (Education and Action for Secure Energy) to provide education and technical assistance for municipalities planning for energy security and resilience
- Kent Land Trust – Creation of a Strategic Workplan to Identify Parcels Enhancing Climate Resilience
- Lower Connecticut River Valley Regional Council of Governments (RiverCOG) – Regional Long Term Recovery-Land Use Resiliency Plan
- Northwest Conservation District – Building Municipal Resilience Using Low Impact Development Design
- University of Connecticut – Natural Resources Conservation Academy: Fostering Young Scientists in Connecticut Communities

The Small Town Economic Assistance Program (STEAP)

The Small Town Economic Assistance Program (CGS Section 4-66g) funds economic development, community conservation, and quality of life capital projects for localities that are ineligible to receive Urban Action (CGS Section 4-66c) bonds. This program is managed by the Office of Policy and Management, and the grants are administered by various state agencies. STEAP funds are issued by the State Bond Commission and can only be used for capital projects. A project is

considered to be a capital project if it is new construction, expansion, renovation or replacement for an existing facility or facilities. Project costs can include the cost of land, engineering, architectural planning, and contract services needed to complete the project. Projects eligible for STEAP funds include:

- Economic development projects such as (a) constructing or rehabilitating commercial, industrial, or mixed-use structures and (b) constructing, reconstructing, or repairing roads, access ways, and other site improvements
- Recreation and solid waste disposal projects
- Pilot historic preservation and redevelopment programs that leverage private funds
- Other kinds of development projects involving economic and community development, transportation, environmental protection, public safety, children and families and social service programs

Past grant awards that are aligned with topics addressed in the Plan include:

- Sanitary sewer improvements
- Sewer pumping station improvements
- Water main extensions
- Groundwater supply development
- Flood mitigation
- Stormwater pollution prevention
- Dam repair and replacement
- Dam removal
- Drainage improvements
- Riverbank stabilization
- Fire protection water source development
- Improvements to public access to water

Interestingly, for FY 2017, priority was given to applications for projects that benefit two or more eligible municipalities. Applications were required to indicate how benefiting municipalities plan to split project costs. This is a potential improvement in the program relative to being a conduit for implementation of actions from the Plan, which by nature should benefit more than one municipality.

6.6.2 Federal Level Funding Sources

Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251), as amended by Section 205 of the 1992 WRDA, provides authority for the U.S. Army Corps of Engineers to assist states, eligible Native American Indian tribes, local governments or other non-federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of

water and related land resources. The "Planning Assistance to States Program" is cost shared on a 50% federal-50% non-federal basis up to $500,000 annually. Typically, individual studies, of which there may be more than one per state or tribe per year, generally cost $25,000 to $75,000. Every year, each state and Native American tribe can provide the Corps its request for studies under the program; the Corps then accommodates as many studies as possible within the funding allotment. Typical studies are only planning level of detail. The program can encompass many types of studies dealing with water resources issues. Types of studies conducted in recent years under the program include the following:

- Water Supply Studies
- Water Quality Studies
- Environmental Conservation/Restoration Studies
- Wetlands Evaluation Studies
- Dam Safety/Failure Studies
- Flood Damage Reduction Studies
- Flood Plain Management Studies

The Clean Water State Revolving Fund (CWSRF) program is a federal-state partnership that provides communities a permanent, independent source of low-cost financing for a wide range of water infrastructure projects. Funding can be used to assist publicly-owned treatment works, nonpoint source pollution management programs, conservation and management programs for estuaries, decentralized wastewater treatment systems, stormwater management improvements, water conservation and efficiency/energy efficiency programs related to publicly owned treatment works, watershed pilot projects, water reuse projects, projects to increase security at publicly owned treatment works, and to obtain technical assistance to plan, develop, and obtain financing for CWSRF eligible projects to assist treatment works in complying with the Clean Water Act. The CWSRF can also issue loans, purchase or refinance a community's debt, issue guarantees or insurance to improve credit market access, and subsidize projects.

The Drinking Water State Revolving Fund (DWSRF) program is a federal-state partnership to help ensure safe drinking water. The program provides financial support to water systems and to state safe water programs. Funding can be used for treatment, transmission and distribution, source rehabilitation, storage, consolidation, and new system projects, although funding is typically restricted to areas with contamination or a need to improve drinking water quality.

Community Development Block Grants (CDBG) from the United States Department of Housing and Urban Development can be used for water and sewer facilities as part of community development activities, including disaster recovery (CDBG-DR). CDBG entitlement communities are additionally eligible to apply for assistance through the section 108 loan guarantee program.

CDBG-DR grants administered by the Connecticut Department of Housing following Hurricane Sandy included numerous projects aligned with the recommendations of the Plan. Two of the largest CDBG-DR grants were awarded to DPH and DEEP, respectively, to evaluate vulnerabilities of water and wastewater facilities and develop resiliency plans. Other examples include the grant

to the Town of Fairfield to evaluate green infrastructure in the downtown area, grants to Fairfield and West Haven associated with making wastewater and sanitary sewer infrastructure more resilient, and the grants to various municipalities to develop resiliency plans that include water, wastewater, and stormwater considerations.

The FEMA Hazard Mitigation Assistance (HMA) program contains three grant programs. Two of the programs (Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA)) are directed at projects that mitigate future risk of damage caused by natural hazards, and these programs are nationally competitive. The third grant program, the Hazard Mitigation Grant Program (HMGP), makes available mitigation funding to states based on counties receiving a presidential disaster declaration, and can be used to rebuild damaged infrastructure in a more resilient manner.

The United States Department of Agriculture Rural Development program provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in towns with 10,000 people or less.

Section 319 of the Federal Clean Water Act (Section 319) is a Federal program to control nonpoint sources (NPS) of water pollution. The Section 319 grant program primarily focuses on addressing NPS impacts in water bodies listed as impaired. Connecticut receives funds for Section 319 grants that can be passed on to communities, local conservation groups, and other organizations for NPS projects, plans, and statewide NPS management efforts. DEEP accepts proposals for Clean Water Section 319 matching grants and administers funds.

DPH Environmental Health Section has received funding from the Department of Health and Human Services – Centers for Disease Control under a cooperative agreement "Environmental Health Services Support for Public Health Drinking Water Programs to Reduce Drinking Water Exposures, CDC-RFA-EH15-1507.

6.6.3 Connection to Implementation

Once a dedicated source (or sources) of funding is established, it is expected that the use of such funding will further the policy recommendations, Pathways Forward, and overall goals of the Plan. Several states have developed guidelines for funding a variety of state water plan implementation projects, which may be considered for implementation in Connecticut.

- Georgia utilized the EPA Clean Water Act State Revolving Fund by writing a justification that the funds would be used for planning that would help meet drinking water capacity needs. The funding was therefore able to be used for technical work.
- Oregon provides infrastructure financing and feasibility study grants for water supply conservation activities, and also provides grants for watershed protection and restoration activities. Using state resources to bridge the gap for funding feasibility studies was considered important.
    - Infrastructure financing is from a combination of revolving loan funds, state and federal grants, and the bond market.
    - Private financial institutions also underwrite bond financing and loans

  - Oregon established the Oregon Watershed Enhancement Board which provides grants with funding from the Oregon Lottery, federal dollars, and salmon license plate revenue.
- Pennsylvania entered into a Joint Funding Agreement with the USGS to perform analyses.

Regional partnerships are another implementation method for consideration. For example, the Whole Watershed Restoration Initiative (WWRI) in Oregon, Washington, and Idaho is a multi-state partnership which offers a competitive salmon habitat restoration grant program. It is a public-private partnership whereby state and federal agencies contribute restoration dollars to the Initiative and then Ecotrust (a non-profit) makes these pooled funds available as grants to local groups for on-the-ground restoration work. The WWRI partnership is comprised of Ecotrust, the Oregon Watershed Enhancement Board, USDA Forest Service, USFWS, NOAA Restoration Center, BLM, and USDA's NRCS. Given Connecticut's current involvement in the Northeast Regional Ocean Council (NROC), this could provide a forum to discuss regional issues or provide a stepping stone to develop a separate regional partnership related to implementation of Plan activities on a regional basis.

Finally, public-private partnerships may be considered. These are identified in some of the Pathways Forward recommendations of this plan.

As an example of how funding sources can be connected to a recommendation of this plan, water conservation recommendations have been linked to possible funding sources in Table 6-4, and similarly, water conservation pathways have been linked in Table 6-5. These are only examples; no recommendations for funding are made in this table, as the WPC would be charged with vetting funding decisions.

6.7 Scenario Planning and Adaptive Management

One method that some states have applied to implement ideas and concepts in statewide water plans involves scenario planning, or building portfolios of options to address specific local or regional needs. The process of developing plausible scenarios of the future, matching portfolios to the scenarios, identifying no/low regrets actions, and using signposts to determine when additional actions may be needed beyond implementation of consensus policy actions has the following benefits:

- It captures a range of uncertainties and risks that can affect the ability to meet water demands in the future
- It selects appropriate and representative supply portfolios to match future scenarios, which gives broad guidance on what types or categories of conservation and supply projects should be implemented
- It identifies near-term, no/low regrets actions that will provide benefits under a range of uncertainties as a foundation to longer term planning
- It provides a framework for incremental implementation beyond no/low regrets actions that uses signposts to determine when such additional actions are needed

Table 6-4. Examples of Funding Sources for Conservation Policy Recommendations

Recommendation from Policy Statement	Funding Source (staff resources)	Funding Source (consulting, equipment, materials, etc.)	Capacities without Funding
Develop an education and outreach strategy that includes water conservation topics.	State budget allocated to permanent agency staff, such as a State Water Conservation Coordinator position	U.S. Army Corps of Engineering planning funds for consultant assistance to implement SWP	Not applicable
Review of existing conservation program implementation and identify opportunities for improvement; review nonrevenue and unaccounted water reported in Water Supply Plans or otherwise reported.	State budget allocated to temporary or part-time agency staff	WUCC consultant funding if conducted 2016-2018	WUCCs (utilize capacities of existing membership)
Adopt policies stating that water providers may conduct comprehensive, integrated water-resource planning geared toward implementing water conservation best practices for all customer classes (residential, industrial, commercial).	Not applicable; WPC may pursue with existing agency staff resources	Not applicable	Not applicable
Document expected passive conservation savings (trend toward lower overall water use as water-efficient fixtures are installed in new homes and replaced in others) and track it over time.	State budget allocated to permanent agency staff (see above)	Not applicable	WUCCs (utilize capacities of existing membership)
Evaluate the funding, technical support, and training necessary to assist water providers in improving the management of their water systems.	State budget allocated to permanent agency staff (see above)	CIRCA grant (cast the research as a resilience project)	An existing CT Section AWWA committee
Incentivize (monetarily or otherwise) water users to retrofit higher water-use landscapes and irrigation systems with lower water-use landscapes /irrigation systems.	State budget allocated to temporary or part-time agency staff	Not applicable	Irrigation industry trade organizations
Provide training that supports local regulatory efforts that shape the ways in which water utilities respond to droughts (in coordination with the State Drought Plan), and also ways in which new construction interacts with water use.	State budget allocated to permanent agency staff (see above)	OPM funding to COGs for support	UConn CLEAR and Sustainable CT
Determine which state agencies govern green infrastructure and green-building, identify barriers, and work with the appropriate agencies to adapt regulations to allow for graywater, green infrastructure, on-site water recycling and other aspects of green developments.	State budget allocated to permanent agency staff (see above)	Not applicable	Sustainable CT, Alliance for Water Efficiency
Collaborate with Irrigation Associations, Landscape Contractors, urban arborists, landscape-related businesses, and property management companies to implement water-efficient landscape installations and maintenance.	State budget allocated to temporary or part-time agency staff (see above)	Not applicable	Irrigation industry trade organizations

Table 6-5. Examples of Funding Sources for Conservation Pathways Forward

Action from Pathway Forward	Funding Source (staff resources)	Funding Source (consulting, equipment, materials, etc.)	Capacities without Funding
Identify conservation incentives that have been successful in Northeast US	State budget allocated to permanent agency staff (see above)	U.S. Army Corps of Engineering planning funds for consultant assistance to implement SWP	An existing CT Section AWWA committee, WUCCs
Identify case studies in CT, including possible pilot cases.	State budget allocated to permanent agency staff (see above)	U.S. Army Corps of Engineering planning funds for consultant assistance to implement SWP	An existing CT Section AWWA committee, WUCCs
Address residential and nonresidential conservation to ensure they are fair and balanced.	State budget allocated to permanent agency staff (see above)	Not applicable	Not applicable
Estimate passive conservation savings potential, and explore ways to accelerate with incentives. Determine whether older appliances and fixtures with higher flow rates are rare or worth incentivizing (monetarily or otherwise) replacement.	State budget allocated to permanent agency staff (see above)	U.S. Army Corps of Engineering planning funds for consultant assistance to implement SWP	An existing CT Section AWWA committee, WUCCs
Monitor water use for plan update, as PWSs have said that they expect a continuous decrease in water demand of about 1% each year.	State budget allocated to permanent agency staff (see above)	Not applicable	Not applicable
Study ongoing efforts of utilities to change to monthly billing, the associated administrative efforts and costs, and whether the month-to-month comparison incentivizes (monetarily or otherwise) customers to monitor water use.	State budget allocated to permanent agency staff (see above)	Not applicable	An existing CT Section AWWA committee, WUCCs
Strive for statewide consistency in conservation guidance.	State budget allocated to permanent agency staff (see above)	Not applicable	An existing CT Section AWWA committee, WUCCs
Encourage green infrastructure to reduce dependence on water for landscaping and other outdoor needs	State budget allocated to temporary or part-time agency staff (see above)	Not applicable	Irrigation industry trade organizations, Sustainable CT, Alliance for Water Efficiency

This process also underscores the critical importance of implementing the consensus policy actions within the next 10 to 15 years. Without the full implementation of these foundational actions, the gap between demands and water supplies may be much greater.

Connecticut, states across the country, and most water providers have utilized traditional predictive water planning processes. These processes have relied on the past as the key to extrapolate the most likely future water planning scenario. Due to the very long timeframe that it takes to build water supply projects, the planning horizon for the Connecticut State Water Plan is 2040. A wide range of uncertainties may present themselves between now and then; therefore, scenario planning is often deemed as the best choice for addressing a state's water supply future. Uncertainties such as Connecticut's future economy and how that will impact population growth, to climate change and how that may affect water supply levels are important to consider. Scenario planning helps explore a broader range of future possibilities and acknowledges that uncertainties can redirect current trends. Furthermore, this section also includes an adaptive management framework, which can be used to determine what actions may need to be implemented over time, depending on several "signposts." This adaptive framework will allow for Connecticut to:

- Be flexible so that it can address critical planning issues in a strategic fashion;
- Identify and prioritize key planning uncertainties; and
- Develop a consensus vision for how Connecticut can meet the challenges and opportunities of the future.

Connecticut's water future is complex. Making wise choices will require a great deal of collaboration among stakeholders across all the basins in the state. State, federal, regional, and local entities throughout Connecticut will have to make many decisions to implement the adaptive management framework outlined in the Plan.

Our decisions must balance a wide range of risks, given the uncertainties that may occur in the future. Some of the risks associated with potential changes in Connecticut's future run quite high and require our consideration. Fortunately, the potential rewards are equally compelling, and a broader understanding of these opportunities can help Connecticut residents work together for a secure water future. The following definitions are used to describe the planning concepts used in this overall framework to incorporate risk and uncertainties:

- Scenario Planning – A planning process that defines complete, plausible scenarios of the future. This concept differs from traditional planning, in which one future is defined without taking into account uncertainties. Scenarios are formulated by assessing key drivers of uncertainty (e.g., economic/demographic growth, climate, environmental regulations, and social values and perspectives) and combining the outcomes of these drivers into a complete picture of what the future might look like.
- Strategies – Groupings of similar projects.
- Portfolios – Combinations of different strategies to meet Municipal and Industrial (M&I) water demands. Portfolios can be matched to future scenarios considering cost, reliability,

the environment and recreation, agriculture, and the feasibility of implementing the portfolio.

- No/Low Regret Actions – Either 1) a set of strategies that are common to all of the portfolios matched to scenarios or 2) strategies that need to be planned for or preserved in order to provide adaptive capacity for one or more scenarios, while not undergoing the risks of fully developing the strategy in question. These actions have benefit under a wide range of uncertainties, and hence should be prioritized for near-term implementation.
- Adaptive Management – A process that develops alternative paths to each one of the future scenarios. Adaptive management reduces the risk of underperforming or over investing as it provides a framework for incremental monitoring of future trends and phased implementation of strategies over time.
- Signposts – Represent decision points by which future drivers of the scenarios will be assessed and actions taken to determine which path of strategies should be implemented. The signposts are directly related to the drivers used to develop the scenarios, but are fewer in number and may represent an aggregate of multiple drivers.

Adaptive Management Framework

An adaptive management framework can be used to determine if and when additional policies or strategies beyond the actions in the Plan should be implemented. Adaptive management has three main elements: (1) signposts, (2) outcomes, and (3) actions.

Signposts

Signposts are decision points based on the most critical drivers that can be used in the development of future scenarios. The following signposts are an example of several drivers that might be used, and are defined as follows:

- Municipal and Industrial (M&I) Water Demands – Based primarily on the tracking of economic and demographic growth, but also account for energy water demands, effectiveness of water efficiency, and urban land use. Water demands can be assessed in the future as being lower or higher than the mid-level water demand forecast used in the Plan.
- Water Supply Availability – Based on a tracking of climate, hydrology, legal constraints associated with registered diversions, and environmental regulations affecting availability of water. Water supplies can be assessed in the future based on their availability factors.
- Social Values – Based on the tracking of values towards land use development, energy use, water use efficiency, agriculture, environment, and recreation, an overall assessment can be made to define social values as being more "green" or better "resource utilization". Green values can dictate more dense, low-impact development; higher reliance on water use efficiency; greater protection of the environment and recreational resources; more energy efficiency; and preservation of agriculture and open space. Resource utilization values can dictate a full use of water supply resources, including new supplies and agricultural transfers, to meet M&I demands.

Outcomes

Outcomes represent alternative paths for the signposts.

Actions

Actions represent the strategies to be implemented based on the outcomes of the signposts. Actions may include: stay the course, acceleration of a previous strategy, or implementation of a new strategy.

Adaptive Management Framework

Figure 6-2 below depicts the way signposts are used to determine which path forward strategies should be implemented in order to arrive at the ultimate policy and pathway tied to a specific scenario of the future. In this example, M&I water demands will be assessed as being higher or lower than mid-level projections; then water supply availability will be assessed as being lower or higher than mid-level projections; and finally social values will be assessed as being more "resource utilization" or "green".

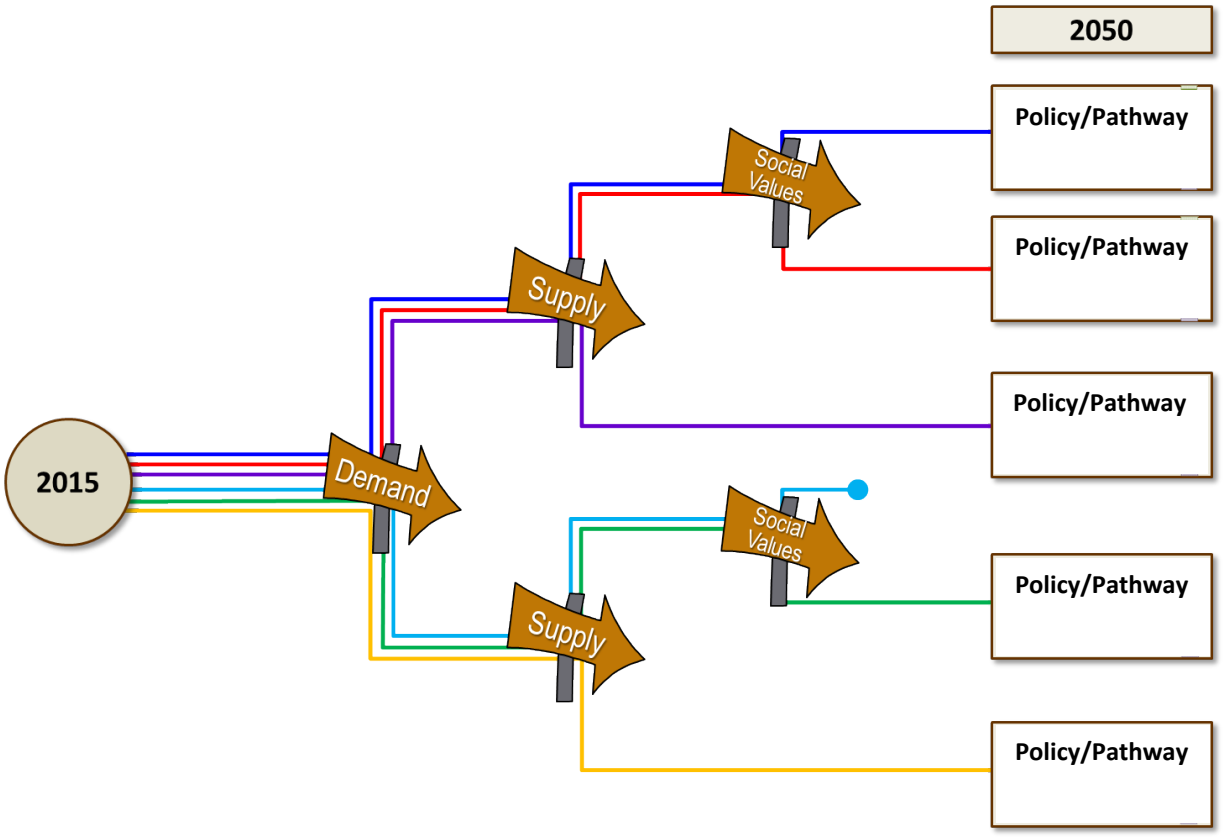


Figure 6-2. Example signposts and how they relate to Connecticut's Water Supply Future Scenarios

6.8 Next Steps

6.8.1 What to Track

The Plan encompasses many goals and strategies for water planning in the state. In order to prevent being overwhelmed with the various components and continuous nature of water planning, it is recommended that priorities for early completion milestones are developed and a means to track progress, with interim status updates, are important.

Earlier in this Section, the 17 statutory requirements are listed to compare during implementation. The implementation of the Plan must always circle back to those requirements.

6.8.2 Near Term goals

The Plan recommends the following near-term steps for the Water Planning Council to take toward implementation (suggested within the next 12 – 18 months, but clearly dependent on available time and resources):

- Prioritize topics and tasks for the WPC to focus on during initial implementation steps related to this Plan's recommendations and ideas.

  One topic risen to the forefront during the public comment period was the prioritization of reconciliation of the Drought Preparedness and Response Plan with the State Water Plan. This evaluation should include input from chief local officials and include considerations for model town ordinances and possible legislative changes. This effort may be a good focus topic effort by the WPC Advisory Group, and the Plan's policy recommendations and pathways forward should be referenced (including 5.2.3.3 Water Conservation Recommendation and 5.3.2.8 Statewide Drought Planning, respectively).
- Hire a Water Plan Chief to oversee all aspects of Plan implementation, serve as a liaison between the WPC and the legislature, and help ensure consistent interpretation of its information and recommendations.
- Begin outreach program, especially to parties who did not participate actively in the development of the Plan, including municipal officials, state lawmakers, etc.
- Identify basins for which simulation modeling could help improve the balance of water uses (possibly from the high-priority basins identified in the Plan), and identify funding mechanisms for initiating basin studies.
- Partner with existing watershed associations and/or establish volunteer River Basin Commissions (as needed) to prioritize local issues in river basins and apply the data and principles in the Plan to recommend action to the WPC (following examples from other states).
- Formulate plans for centralized data portal and assign this to a specific agency or organization.
- Seek funding for policy recommendations that require financial support (outreach, data collection and consolidation, etc.).

- Review the Plan recommendations to determine if and when to propose specific legislation. This may involve briefings with law makers and/or collaborative working sessions.

6.8.3 5-Year Goals

5-year goals should include continuing those actions that are implementable but may need a bit more time to find the correct path and involve appropriate stakeholders. Those policy recommendations that are not implemented during the first year or two should fall within this 5-year period.

Also, while this Plan included an evaluation of the range of climate trends over the next 25 years, and a general assessment of possible impacts statewide, it is recommended that climate change be studied further and with more specificity. Specifically, the WPC should consider the following:

- Evaluation of coastal flooding frequency, duration, and depth based on storm surge patterns and sea level rise.
- Evaluation of potential impacts to water supply in specific basins known to be at risk of not satisfying all future water needs (per the information in this report).
- Evaluation of potential longer-term climate trends, extending 50 or 100 years into the future – not as predictions, but as a way to bound the ranges of possible conditions for which adaptive and preemptive measures can be taken.
- Follow a growing nationwide trend of formulating preemptive responses to ANY future climate trend (sometimes referred to as "no regret" decisions), which will yield benefits regardless of the way the climate trends at low cost and low risk. Examples may include system-specific drought indicators, early warning systems for floods, incentives for green infrastructure to promote recharge, reduce runoff peaks, and help control nonpoint source pollution.

6.8.4 Plan Review Cycles

In addition to tracking progress, the Plan itself must be revisited at periodic times to correct any known errors and to supplement with newer additional data sources. Many states formally update their water plans every 5 years. The WPC should determine if a 5-year recommended cycle is recommended for the Connecticut State Water Plan. Specifically, the next revision of the Plan should include sections on:

- How data gaps have been filled (including as related to the 2017 Freedom of Information Act modifications)
- Review of basin risk based on refined and/or updated information
- Results and interpretation of basin modeling that may have originated as a result of this Plan to look at specific, localized issues
- Results of the work of any volunteer basin commissions that may be established in response to this Plan to apply its overarching principles to local decision-making, as well as an overall assessment of this method of combining top-down guidance with grass-roots application.

- New laws and regulations that resulted from this version of the Plan
- Continuing evaluation of the WPC and its subcommittees in order to refine the group's effectiveness
- Recommendations for further enhancements or changes to the state's water policies, laws, and regulations.

6.8.5 Possible Future Legislation

The Plan does not recommend specific legislation, but its policy recommendations are intended to help formulate consistent future legislation aimed at preserving and improving the balance of water uses throughout the state. Several examples of potential legislation that stakeholders envision might arise from the implementation of the Plan include:

- Revoking obsolete diversion registrations
- Water conservation laws or incentives in concert with ongoing utility initiatives
- Private well testing program
- Statutory authority for the Water Planning Council to engage a "Water Plan Chief," provide binding or non-binding arbitration, and appoint an impartial mediator for certain cases.

6.8.6 Additional Topics for WPC Discussion

During the Public Comment Period from July – November 2017, many comments focused on clarifications to the Plan, voiced support of the Plan's recommendations, expressed desire for the language in the Plan to be stronger, or suggested that certain issues should be high priorities as the Plan moves toward adoption and subsequent implementation steps.

The Water Planning Council will prioritize the recommendations within the Plan. In addition to some of the near-term priorities identified in this section, other issues in this report may rise to immediate prominence. In addition to the topics covered in detail by this plan and its recommendations, many other water management topics were noted by readers who offered comments on the report. These new topics, while they did not rise to prominence during the stakeholder deliberations while the Plan was under development, are noted here as worthy of future discussion by the WPC, inclusion in the discussion of prioritization of near term and long-term steps, and perhaps further work as the Plan is revised and updated in years to come.

Additional topics offered by readers during the public comment period for consideration of the Water Planning Council:

- Water as a public trust in the context of existing statutes and the themes of "balance between all uses" in this Plan (reference Section 22a-15 of the Connecticut General Statutes, and Section 2.2.1 of this Plan)
- Further guidance on how to use the Plan to support discussions on large water uses, including water bottling

- Health equity and health equity initiatives to ensure all state residents have equal access to safe, high quality, affordable and adequate drinking water with a focus on public health protection and disease prevention
- Environmental equity, including that no segment of the population should bear a disproportionate share of the risks and consequences of environmental pollution or be denied equal access to environmental benefits (reference DEEP's Environmental Equity Policy)
- Harmonizing energy priorities with the stewardship of water
- Transparency and local involvement in decisions on how water is used and where it can be transferred
- Emerging and re-emerging contaminants (including chlorides and perfluoroalkyl substances (PFASs), for example)
- Stormwater management in addition to ongoing initiatives
- Green infrastructure and low-impact development, specifically how these can be incentivized
- Dam removal: future discussion can reference the current policy assessment as included in Section 2 of the Plan, including Sections WP13.1 Dam Safety and WP1-18.3 Dam Removals and Fish Passage
- Biosolids and other wastewater related topics
- Water quality in Long Island Sound (ensuring the Plan supports or augments current efforts)
- Decentralized sewage systems
- Further work on climate change, specifically inland flooding potential (not covered by coastal studies), and impacts on future drought risks
- Additional work on agricultural and industrial water needs, uses, and practices

Again, these topics were noted during the public comment period by readers of the Plan as worthy of further discussion, and even though they may not have been prevalent during the year of deliberations, workshops, and discussions during development of the Plan, the WPC has agreed that they are worthy of inclusion in ongoing discussions about how to prioritize near-term and long-term implementation steps.

Section 7
Summary and Conclusions

7.1 Technical Conclusions

Does Connecticut Have Enough Water? One of the fundamental questions underpinning the policy recommendations focuses on both the perception and reality of Connecticut's water sufficiency. In other words, the question was: "Does Connecticut have enough water?" The answer changes based on three factors: The types of conditions being evaluated, the types of water needs being considered, and the potential exercising of unused registered diversions. Generally, while there should be sufficient drinking water in the state between now and 2040, especially considering storage and potential future conservation measures, there may be conditions that make it difficult for a basin to satisfy all out-of-stream and instream needs at the same time in all locations.

The basin summary sheets in Appendix E and the basin maps in Sections 2 and 3 indicate that on an average daily basis, the basins in Connecticut appear to be well supplied with water to meet the needs of current and projected future out-of-stream uses. When instream uses, including those necessary to support aquatic life are considered, gaps become apparent especially in the summer months, although storage and flow management plans may alleviate this to varying degrees. Again, the maps and fact sheets offer indications of potential stress within basins, but do not necessarily forecast overuse or underuse. It is also important to remember that because these data are regionalized by basin, they are indicators of potential future stress, and not actual predictions of future stress. Water may be plentiful basin-wide, but it is possible that the right quality and quantity of water may not be available at the locations where it is needed all the time. Detailed evaluations of specific utilities or water systems would be required to identify where and when stress could occur (see example of a river basin model in Section 3.1.6, and also the three examples of how to interpret the maps and fact sheets in the Executive Summary).

With this understanding, **Table 7-1**, which includes both surface water and groundwater, summarizes the principal technical findings of the State Water Plan, and suggests that many basins in the state are potentially at risk of not satisfying all water needs all the time and in all locations. Again, it is important to note that this does not mean that water may be scarce in all locations at all times in a basin, but rather, that the possibility exists in some localized areas within certain basins that conditions may make it difficult to satisfy all instream and out-of-stream needs at the same time. The data in this table is taken from examination of the Basin Summary Sheets in Appendix E. Note that these risks do not include potential offsets from existing storage (which is summarized in Section 3 of the report), or potential conservation measures. The table presents a summary of all needs, and a breakdown of risks based on instream or out-of-stream needs only, because while the Plan strives to balance these two needs, it is important to understand constituent contributors to future risks.

Table 7-1. Percentage of Basins at Risk of Not Satisfying Water Needs*

Hydrology and Demand Conditions (Today through 2040)**	Approximate Number of Regional Basins Potentially at Risk of Not Satisfying Needs (out of 44)		
	Out-of-Stream AND Instream Needs	Out-of-Stream Needs Only	Instream Needs Only
Average Annual	4	0	1
Typical Summer	13	7	1
Severe Drought Month	44***	22	44***
Average Annual, with all unused registered diversions exercised	22	15	NA

* This table does NOT account for storage, which can offset short-term seasonal risks significantly

** No major changes in demand are expected between now and 2040. Climate change results suggest only slightly less water availability in the summer, which may be offset by storing projected higher runoff values earlier in the year.

** This does NOT mean that 100% of rivers or river reaches are at risk, but rather, that there may be tributary reaches in each basin that could be at risk.

What are the Risks of Climate Change? The analysis presented in this report suggests that future climate trends throughout the state are likely to lead to higher risks of flooding during the winter months, and potentially lower streamflows during summer months. The potential departure from historic norms is likely to be more significant with respect to flood risk – that is, flows are likely to increase in the winter by a higher percentage than that by which they would decrease during the summer (and under certain conditions, summer flows may not actually decrease). The analysis did not evaluate the potential frequency of droughts, but the lower flow projections in the summer suggest more frequent occurrences of short-term seasonal droughts, which could increase risks of many basins in Connecticut that rely on small drainage areas with less than 2 or 3 months of storage capacity in reservoirs.

Is there Significant Conservation Potential? Analysis based on water use patterns and demographics in each basin suggest that long-term adaptations in residential and commercial water use coupled with drought response cutbacks could produce conservation levels that are not insignificant (on the order of 10-20%). The analysis did not specifically address improvements in industrial or agricultural water use efficiency. However, the analysis did not distinguish future conservation potential from conservation already attributable to progressive initiatives sponsored by individual water utilities and to long-term passive conservation (expected to continue) yielding significant reductions in water use owing to plumbing codes, fixture replacement, etc. It is recommended that further study for each water system be conducted to determine upper bounds on conservation expectations, both long term and during droughts. In some cases, such conservation could help reduce the risks indicated in Table 7-1 above. Regardless of the quantitative impact on risk reduction, the Plan strongly advocates for enhanced conservation throughout the state to help guard against future uncertainties in climate, economic growth, and regulatory conditions.

Technical Data: Of critical importance to the understanding and use of the technical observations in this State Water Plan is the recognition that significant data gaps still exist. Not all water uses are reported, and water availability could be better understood with continued and expanded river and groundwater gaging. The Plan lists and explains the current data gaps in Section 2.1.2.2, and recommends improved data gathering practices in Sections 5.2.3.12 and 5.3.2.10. For detailed river basin planning that applies the guiding principles and risk levels of this overarching Plan (as discussed in Section 3.1.6), additional local data will be required through cooperation with utilities, municipalities, and local industries and agricultural interests.

7.2 Promoting Balanced Water Use

The overarching goal of the Plan, as defined by stakeholders, has been to balance all water needs. Quantitatively, these needs have been divided into instream needs (for ecological health, recreation, and aesthetics), and out-of-stream needs (for drinking water, industry, agriculture, energy, etc.). Another way to consider this balance, though, from a policy point of view is by applying the criteria of the "Triple Bottom Line" philosophy, whereby decisions should give balanced consideration to social, environmental, and economic impacts. In the context of the State Water Plan, the policies and recommendations expressed in previous sections can frequently be linked to Human Health, Environmental Health, and Consideration of Economic Factors. The paragraphs below explain how and where the Plan specifically addresses these needs, in the interest of balancing them:

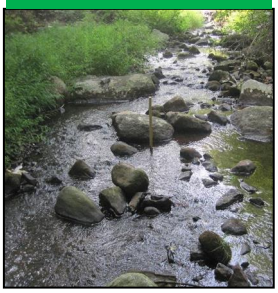
Human Health



The Plan focuses significant attention on the preservation of high quality water for public health. Specifically, it strongly reaffirms the state's commitment to using only Class A water (the highest quality water occurring naturally) for human consumption (Section 5.2.3.11). The Plan also endorses land protection measured for both surface water bodies and groundwater aquifers so that this high quality of drinking water can be preserved into the future (Section 5.2.3.1). It is important to note that these land protection measures were deemed to be among the Top-Ten policy recommendations in the Plan. Also among the Top-Ten policy recommendations are three sets of measures aimed at increasing the availability of Class A water in the future, or at least reducing the impact of expanded dependence upon it. The first is increased conservation practices throughout the state, following the example already established by many water utilities (Sections 5.2.3.3 and 5.3.2.1). Second, the Plan recommends that Class B water be considered more routinely for non-potable uses in the future, thereby reducing the out-of-stream use of Class A water for uses that could be lawfully satisfied with other sources (Section 5.2.3.11). Third, the Plan recommends progressive agricultural practices to help reduce impacts of irrigation on other water needs (Section 5.2.3.6). If these recommendations are codified into policy, laws, and/or regulations, the State of Connecticut will have taken important steps toward securing the highest quality of drinking water in the United States for its citizens well into the future. These steps should be accomplished with the understanding that competing needs for water exist in almost every basin in the state, and that the state's new regulations for reservoir releases to support ecological needs downstream of water supply reservoirs can limit the availability of Class A water for future drinking water needs. The steps recommended here to

preserve, protect, and enhance Connecticut's Class A water supply sources would be an effective step in balancing human health with environmental health.

Environmental Health



The Plan sheds a great deal of light on new information concerning ecological flow needs in streams throughout the state. In addition to the state's new regulations on Minimum Streamflow Requirements downstream of certain reservoirs, which the Plan endorses in Section 5.2.3.8, the Plan focuses new attention on estimated flow requirements throughout each basin in order to help maintain good ecological health (see Sections 2 and 3, and the Basin Summary Sheets in Appendix E). While the Plan does not recommend that the estimated ecological flow needs be used in a regulatory context beyond the existing Minimum Streamflow Requirements, the Plan does recommend that they be further studied in order to determine potentially allowable variances during periods of drought, and to better understand the impact of maintaining instream flow on water supply yield, margin of safety, and cost (Section 5.3.2.11). It should also be noted that the estimates of ecological flow needs are necessarily generalized at the regional basin level, and specific needs in local reaches would require further study. The Plan further emphasizes the need to preserve environmental health by encouraging the state to render unused diversion registrations (or certain unused portions of registrations) obsolete, thereby protecting water bodies from future increases in withdrawals beyond what is already expected and planned for (Section 5.2.3.7). Also, the conservation initiatives discussed above, in addition to promoting the future adequacy of Class A water supply for human health, will also help ensure that more flow can remain in the streams to satisfy environmental needs (Sections 5.2.3.3 and 5.3.2.1). From a water quality point of view, the Plan recommends certain land management practices aimed at preserving or improving water quality throughout the state (Section 5.2.3.2). While many of the environmental aspects of the Plan focus on ecological needs, "environmental health" is more broadly addressed in the Plan as the protection of aquatic habitat and the protection of natural resources, both land and water, on which human and non-human life depend. With the endorsements in the Plan noted above, the new information on ecological flow needs throughout the state, and recommendations on how to promote improved instream flow and water quality conditions, the State will have taken important steps toward balancing human and environmental health.

Economic Cost and Benefits



The Plan does not specifically aim to increase economic growth and development, but its recommendations do strive to create awareness of the potential economic impacts associated with water management decisions, and also serve as a platform to indicate where water may be plentiful enough to support future economic growth, and it may be wise to review the basin summary sheets and in Appendix E and individual municipal/utility water supply plans with the Connecticut Economic Resource Center (CERC). It also provides a documented basis for implementing progressive water management strategies only where it makes economic sense to do so. Recommendations for better understanding economic impacts of water management are included in Section 5.3.2.5. This section discusses the possibility of an evaluation that

compares the implementation of the Plan to NOT implementing the Plan, using either purely financial metrics, or applying Triple Bottom Line methods (social, environmental, and economic), following the example of this section. The Plan also recommends that the WPC determine if there is a consistent way to associate financial value of water for the needs represented in the Plan (including recreational and environmental) and the different types of utility ownership throughout the state. This section also recommends partnerships with Sustainable Connecticut and colleges and universities to address these informational and analytical needs, and concludes by recommending that the WPC formulate a template such that all water-related proposals offered for legislative consideration are accompanied by a consistent financial analysis. In other areas of the report, the Plan recommends that specific economic impacts associated with policy recommendations or next steps be considered. Section 5.3.2.11 recommends that the WPC study the financial impacts of regulatory reservoir releases associated with Minimum Streamflow Requirements. Section 5.3.2.7, which recommends consideration of Class B water for non-potable uses, clearly states that current any potential uses (new or conversions) should be evaluated for cost-effectiveness, and that case studies should be developed to better understand the potential costs (or cost savings) of infrastructure and treatment. Section 5.3.2.2 makes similar recommendations with respect to the possible case-by-case evaluations of regionalizing water systems. Likewise, Section 5.3.2.1 recommends further examination of the economic viability and potential benefits of conservation incentives and changes in billing frequency.

7.3 Applying the Plan

To accomplish this balance, the Plan offers a comprehensive inventory of data on water needs and availability, consensus-based recommendations for water policies that can serve as guiding principles for future laws, regulations, and site-specific decisions, and next steps (Pathways Forward) for issues that require more information, outreach, or consensus-building. As decision makers in Connecticut use this Plan, they will succeed in improving the balance of water uses throughout the state and the equity with which water is used if they remember that the Plan itself is not the answer, but the first-ever compilation of information and principles in Connecticut on which consistent water decisions can be defensibly based.

APPENDIX A

State Water Plan Fact Sheet

State Water Plan
CONNECTICUT

Long Island Sound and Lake Saltonstall, East Haven/Branford

Overview of the State Water Plan

Public Act 14-163 instructs the Connecticut Water Planning Council (CT WPC) to develop a State Water Plan for the management of the water resources of the state. The statute requires that the plan balance the needs of public water supply, economic development, recreation, and ecological health. The statute also requires that the WPC seek stakeholder input, which will be solicited at meetings and workshops that are an integral part of developing the State Water Plan. In May 2016, CT WPC, which is comprised of four agencies: The Department of Energy and Environmental Protection (DEEP); Department of Public Health (DPH); Office of Policy & Management (OPM) and Public Utilities Regulatory Authority (PURA), with NEIWPCC providing management assistance to the WPC, contracted CDM Smith (Boston, MA) and Milone & MacBroom (Cheshire, CT) to assist with the development of the CT State Water Plan, which is projected to be completed in draft form by April 2017.

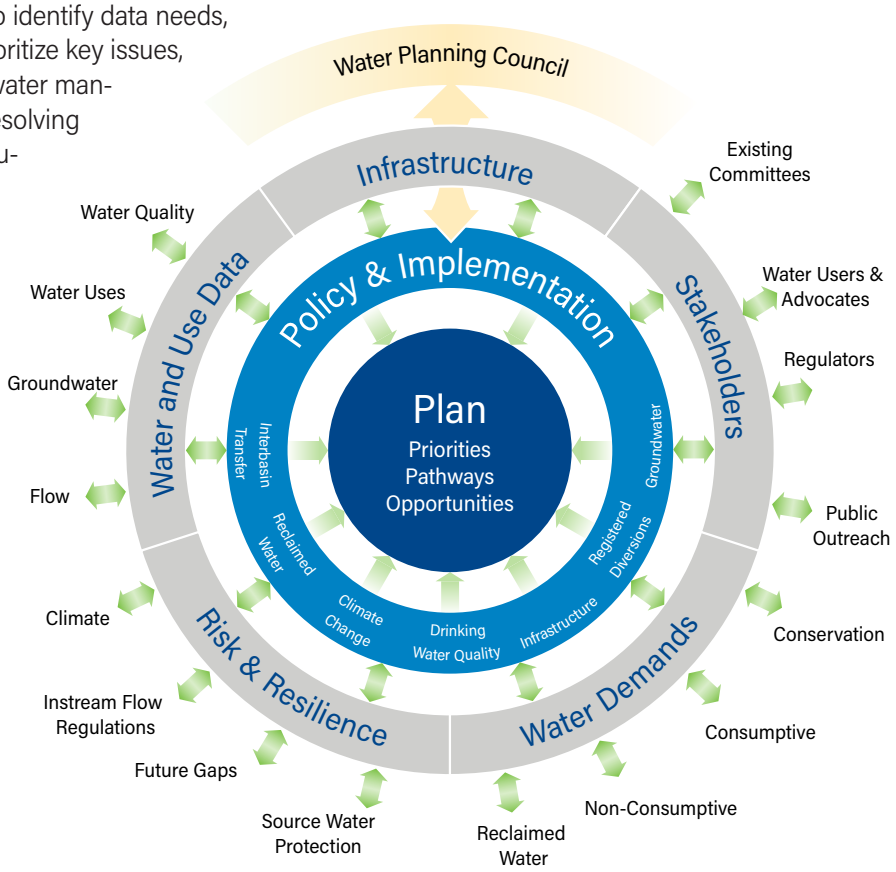


Killingworth Reservoir Wetland Mitigation Area

The State Water Plan is intended to be a framework to identify data needs, recommend policies and management strategies, prioritize key issues, identify opportunities for improved or more efficient water management in the future, and identify mechanisms for resolving conflict. It is not intended to provide answers or resolution to all of Connecticut's water issues. Workshops throughout the planning process will help define reasonable end-goals for each water issue to be addressed, whether the goal be a consensus-based and science-based policy recommendation, or a framework for further information gathering and decision making. In the process of developing the State Water Plan, the CT WPC will build on the water planning work to date, and seek to find areas of consensus and pathways toward progress.



Farmington River Recreation Area at Upper Collinsville Mill Pond



The circular diagram represents a summary of the many components that will be considered and incorporated into the State Water Plan.

The Plan will be developed in two phases. Phase I will focus mostly on data collection and current condition assessment. Phase II will focus more on stakeholder engagement and progress toward a consensus-based Plan.

Phase I Goals:

- Establish definition of the plan, its objectives, and its processes.
- Assess current conditions and practices.
- Evaluate future conditions.
- Prioritize issues and alternatives for Phase II.

Phase II Goals:

- Develop consensus-based policy recommendations where possible.
- Develop pathways toward resolution of unresolved issues.
- Formulate a decision framework for ongoing and future water issues.
- Define opportunities for regional collaboration.

Upcoming Meetings

Phase I Public Outreach Meetings

·Tuesday, October 25: 6:00 – 8:00 PM
Southeastern CT Council of Governments,
5 Connecticut Avenue, Norwich, CT. New Britain, CT 06050

·Wednesday, October 26: 1:00 – 3:00 PM
Hearing Room 1 at PURA, 10 Franklin Square, New Britain, CT.

·Thursday, October 27: 6:00 – 8:00 PM
Room 205 of the Southbury Town Hall, 501 Main Street South, Southbury, CT.

Phase II Stakeholder Workshops (location to be determined):
November 17, 2016 January 12, 2017 February 2, 2017
February 16, 2017 April 20, 2017

Phase II Public Meetings (specific days and location to be determined):
Following workshop sequence: January 2017, February 2017, and April 2017


Kleen Energy Generating Facility


UConn Reclaimed Water Facility


Headwater Stream in Public Water Supply Watershed


Nursery Irrigation Pond

Schedule

Phase I: May – November 2016

MAY | JUN | JUL | AUG | SEP | OCT | NOV

- 1 Stakeholder Workshop Meeting (held September 29, 2016)
- 3 Public Outreach Meetings (see below, October 2016)
- Draft Report: Data Collection, Identification of Data Gaps, and Policy Evaluation, Nov. 2016

Phase II: December 2016 – April 2017

DEC | JAN | FEB | MAR | APR

- 5 Stakeholder Workshop Meetings
- 3 Public Outreach Meetings
- Draft State Water Plan delivery for WPC review, April 2017

Points of Contact

Kirk Westphal, PE
Project Manager, CDM Smith
75 State Street, Suite 701
Boston, MA 02109
617-452-6440
WestphalKS@cdmsmith.com

David Murphy, PE, CFM
Milone & MacBroom
99 Realty Drive
Cheshire, CT 06410
203-271-1773 Ext. 295
DaveM@miloneandmacbroom.com

Mike Jennings
Senior Program Manager, NEIWPCC
650 Suffolk Street – Suite 410
Lowell, MA 01854
p: 978-349-2520
f: 978-323-7919
MJennings@neiwpcc.org

DPH Keeping Connecticut Healthy OPM PURA

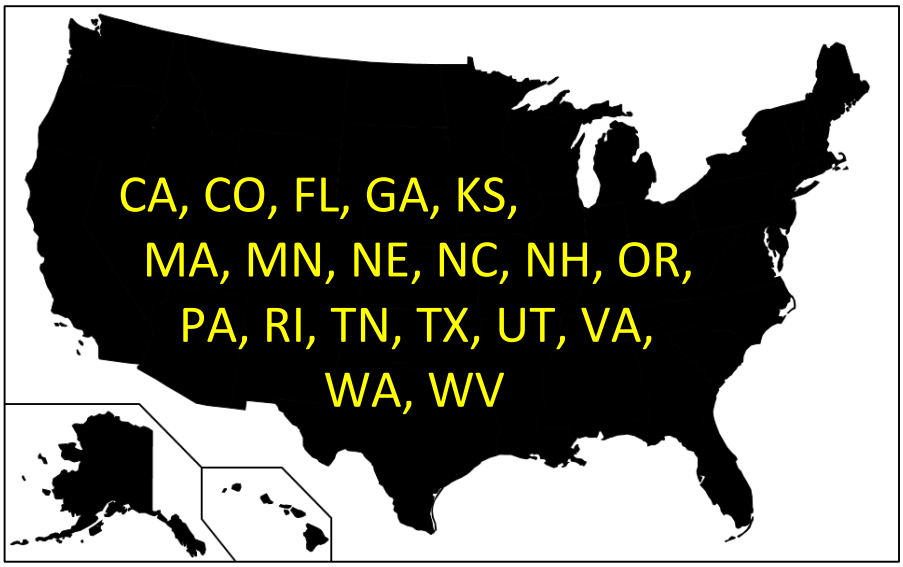
For more information on the CT State Water Plan, please visit **www.ct.gov/water**
Comments submitted are included in the PURA docket number 14-08-09

APPENDIX B

Other States' Plans Work Group Report

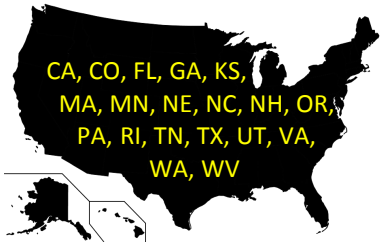
CONNECTICUT WATER PLANNING COUNCIL ADVISORY GROUP

Final Report of the
Other States' Water Plans Workgroup



June 5, 2015

OTHER STATES' WATER PLANS



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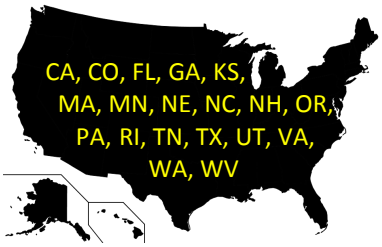
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Appendix 3. State Plan Evaluation Questions

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Appendix 4. Summaries of Selected State Water Plans
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OTHER STATES' WATER PLANS



Executive Summary

The Other States' Plans Workgroup was charged by the Water Planning Council to review water plans developed by other states to glean any information applicable to the development of the Connecticut Water Plan. Using Public Act 14-163, "An Act Concerning the Responsibilities of the Water Planning Council" as the context, the Other States' Plans Workgroup reviewed the state plans developed by nineteen other states. Detailed summaries of the other state plans were compiled and elements that would be helpful in Connecticut's process were highlighted. For discussion purposes in this document, these elements are divided into two categories; "planning principles", and "key elements". The difference between the two categories is that "principles" are generally more philosophical in nature and "elements" are related more to the implementation (or mechanics) of the plan.

Box 1: Water Planning Principles:

1. Ensure on-going, dedicated funding
2. Be science based with objective, supportable data and modeling
3. Include a public and stakeholder engagement process
4. Employ an integrated approach
5 Ensure an equitable and fair process for balancing values
6. Maintain an on-going, iterative planning process
7. Have planning drive policy and legislative changes
8. Encourage conservation
9. Include a comprehensive education program

Nine over-arching water planning principles emerged from this review (see Box 1); The most effective state plans consistently held to these principles. The Other States' Plans Workgroup believes that for Connecticut's water plan to be implementable and effective, the state must commit to these principles in the planning process.

Several dozen key elements of a state water plan and the planning process also were identified using both requirements in PA 14-164 and information in other states' plans (see Box 2). These are grouped by (1) state-level institutional and process elements; (2) regional and local elements; and (3) water resource assessment elements. Detailed information on how other states handled these elements is summarized in a table. Also in the table are comments and cautionary thoughts on those elements, where applicable, and web links to outstanding examples.

Box 2: Key Elements of a State Water Plan include:

1. State-level institutional and process elements
2. Regional water planning process elements
3. Water resource assessment

Several of the elements related to policy issues

identified in previous Connecticut water planning discussions. How other states have grappled with these issues and how they addressed them may inform Connecticut's process.

Finally, a model Table of Contents was drafted, compiled from other states' plans. This is intended simply to highlight components common to many of the other states' plans and serve as a guide for the writers of Connecticut's State Water Plan.

The work of the Other States' Plans Workgroup was not intended to be comprehensive, rather it was an attempt to glean the best information we could find in a short amount of time to inform Connecticut's water planning process. The workgroup membership was very diverse, encompassing a full range of water stakeholders. The information presented in this report represents a consensus of the workgroup.

Introduction

Although Connecticut is a relatively water rich state, the water is not always where we need it at the time we need it and competition for limited water resources can occur. Competition occurs despite the existence of different types of planning and management requirements (Plans of Conservation and Development, Water Supply Plans, etc.). To minimize potential future conflicts and to address a range of uncertainties such as climate change, land use change, population growth, economic growth, and water demand, Connecticut recognized the need for a comprehensive state water planning and management framework.

The state legislature signaled an important step in addressing this need for a comprehensive state water planning and management framework with the passage of Public Act 17-177 and subsequently Public Act 14-163 (PA 14-163), An Act Concerning the Responsibilities of the Water Planning Council (WPC). This act requires the WPC to prepare a State Water Plan for management of the water resources of the state by July 1, 2017. The Act outlines ten required actions for the WPC and 17 required factors for the plan itself (see box below).

To support and inform WPC's State Water Plan development efforts, the WPC designated the "Other States' Plans Workgroup" (OSPW) as a formal workgroup of the WPC Advisory Group to review other state water plans and water planning processes. Members of the workgroup came from a diverse array of water backgrounds, including academia, government, water utilities, watershed associations, environmental advocates, and consulting. The purpose of the review was to: understand the range of possible approaches to planning that other states employ, assess the respective strengths and weaknesses of those approaches, and, based on that assessment, identify the best state water planning practices applicable to Connecticut.

Most of the factors contributing to effective water plans in other states are included in PA 14-163. The OSPW review sought to identify how other states' water plans addressed those factors and what contributed to an effective plan.

Out of the comprehensive review, the OSPW identified nine overarching principles essential for developing a workable, effective plan and planning process and numerous key "elements."" While the planning principles are broad, fundamental concepts, the elements are more specific recommendations for designing an effective, comprehensive state water plan and planning process in Connecticut. The planning principles are: 1) ongoing funding; 2) based on science and data-driven; 3) public and stakeholder process; 4) integrated approach; 5) equitable and fair process for balancing values; 6) ongoing, iterative planning; 7) planning informs policy and legislative change; 8) conservation, and 9) public education. The key elements for designing an effective state water plan and process include recommendations for: specific institutional and organizational components at the state and regional /local levels and components for effective assessment of water resources and of current and future water resources needs. The OSPW gathered information on how other states handled several previously identified policy issues specific to Connecticut, including: 1) diversion registrations, 2) use of Class B waters, 3) State program administration, and 4) FOI and water security. Finally, the OSPW compiled a model

Table of Contents comprised of topics common to most states' plans to serve as a starting point for Connecticut's Water Plan.

Public Act 14-163: The state water plan developed shall:

(1) Identify the quantities and qualities of water surface and groundwater that are available for public water supply, health, economic, recreation and environmental benefits on a regional basin scale considering both surface water and groundwater;
(2) identify present and projected demands for water resources on a state-wide and regional basin scale;
(3) recommend the utilization of the state'suse of water resources, including surface and subsurface water, in a manner that balances public water supply, economic development, recreation, and ecological health;
(4) recommend steps to increase the climate resiliency of existing water resources and infrastructure;
(5) make recommendations for technology and infrastructure upgrades, interconnections and such major engineering works or special districts which may be necessary, including the need, timing and general cost thereof;
(6) recommend land use and other measures, including assessment of land acquisition or land protection needs, where appropriate to ensure the desired quality and quantity of water and to promote development in concert with available water resources;
(7) take into account desired ecological, recreational, agricultural, industrial and commercial use of water bodies;
(8) inform residents of the state about the importance of water-resource stewardship and conservation;
(9) establish conservation guidelines and incentives for consumer water conservation with due consideration for including energy efficiency;
(10) develop a water reuse policy with incentives, for matching the quality of water to the use quality to use;
(11) meet data collection and analysis needs to provide for data driven water planning and permitting decisions;
(12) take into account the ecological, environmental, public health and safety and economic impact that implementation of the state water plan implementation will have on the state;
(13) include short and long-range objectives and strategies to communicate and implement the plan;
(14) seek to incorporate regional and local other plans and programs for water use and management and plans for water and sewerage facilities in the state water plan;
(15) promote intra-regional solutions and sharing of water resources;
(16) develop and recommend strategies to address climate resiliency including the impact of extreme weather events; and
(17) identify modifications to laws and regulations that are necessary in order to implement the

This report summarizes the work of the OSPW. It describes the planning principles and key elements and shows the range of observed practices in other states that may be instructive to development of the Connecticut Water Plan. To the extent possible, it includes specific examples and points to appendices and outside sources for further details. Together, the recommended planning principles and elements provide an opportunity to build on successes observed in other states' planning efforts while avoiding their mistakes.

The members of the OSPW respectfully submit this report for consideration by the WPC, WPC Advisory Group, State Water Plan Steering Committee and its advisory groups, and other interested parties as Connecticut seeks to meet the challenge to deliver a comprehensive and effective State Water Plan by 2017.

Background and Other State Plans Review Process

Members of the OSPW met regularly from November 2014 through May 2015. The first meeting focused on reviewing the official charge for the group, nominating candidate states for review, and developing and refining Water Plan Evaluation Questions, many of which were drawn from specifics in PA 14-163. These questions covered a range of topics from the water governance and policy framework for the state, including responsible agencies, to specifics about the planning process and scope, to questions about public education, conflict resolution, similarities and differences relative to Connecticut, as well as how well the plan and planning process works. The complete list of Water Plan Evaluation Questions is included in Appendix 1.

Using the detailed Water Plan Evaluation Questions, the OSPW members reviewed water planning efforts in 19 states, with most state plans being reviewed by two members to provide a broader perspective and as a check and balance to ensure completeness. The 19 states were chosen based on similar summaries done for Georgia and Tennessee and on recommendations by members of the workgroup. The OSPW had limited time and therefore focused effort on state plans felt to be most useful for Connecticut. To the extent practicable, the questions helped guide the reviewers to identify and highlight the elements most pertinent to the water planning questions facing Connecticut. In addition, the use of a common set of questions helped members compare across states and, in some cases, identify states' unfinished planning efforts. Using the detailed summaries from each state, the OSPW produced short, concise state summaries focusing on high priority topics including stakeholder engagement, funding and responsible agencies, prioritization processes, and perceived acceptability of data and models. Subsequent meetings provided opportunities for workgroup members to present and discuss the findings from each state, and to prepare overall recommendations including the high-level commitments and the essential elements needed to guide development of Connecticut's State Water Plan. Documents created as part of the review process are available at http://streamingwater.org/drafts/.

Water Planning Principles

In reviewing other state plans, a number of principles emerged that seemed to consistently be represented in water plans that were successfully and actively incorporated into the water governance structure of the state. The OSWP recommends incorporating these

Box 1: Water Planning Principles:

1. Ensure on-going, dedicated funding
2. Be science based with objective, supportable data and modeling
3. Include a public and stakeholder engagement process
4. Employ an integrated approach
5. Ensure an equitable and fair process for balancing values
6. Maintain an on-going, iterative planning process
7. Have planning drive policy and legislative changes
8. Encourage conservation
9. Include a comprehensive education program

principles into the Connecticut Water Plan. There is overlap and connection between all of these principles, and each is important to the overall planning process.

Water Planning Principle 1: Ongoing Funding

Review of other states' water plans revealed the importance of a dedicated, sufficient, and sustained funding mechanism for writing and implementing an effective state water plan. PA 14-163 does not specifically address on-going funding. However, when funding was not consistently available, states were not able to define a course of action or initiate and or maintain planning activities. As a result, management of water resources in those states was fragmented, incomplete, and crisis-driven.

States employed different mechanisms to fund water planning. For example, Colorado uses fees from water users and developers to fund the Colorado Water Conservation Board, the major state agency for water planning and regulation. The steady funding enabled the creation of the first Colorado State Water Plan as well as ongoing planning efforts. In Minnesota, a percentage of sales tax collected annually provides ongoing funding for water-related planning and projects. Nebraska employs a combination of property tax revenue and legislative funds. Despite having multiple sources of funding, the state found current funding levels to be insufficient to support regional water planning. In response, a 2013 state water funding task force report recommended project prioritization and alternative methods of water plan support.

Less successful state water planning efforts often were associated with specific, one-time funding authorizations from the state legislature, typically driven by a drought or other crisis. In New Hampshire, a continual lack of funding hampers advancement of their state water plan, which has not progressed beyond the initial "planning for the plan" effort. Similarly, in Pennsylvania, a state water plan was produced but never fully implemented because of a lack of funding. Planning efforts in Georgia, a state with historically robust planning process, have stalled recently due to diminished funding from the legislature.

Effective water planning and management requires the availability of funding for both developing the plan and for on-going tasks such as periodic report updates, ongoing data collection, modeling, and conservation efforts.

Water Planning Principle 2: Based on Science and Data-Driven

A critical component of a successful state water planning process is a commitment that it be science-based and data-driven. Such a commitment will help ensure the process is transparent to policy makers, policy implementers, the regulated community, and the public. Without sound science, the plan will not be able to deliver on all of its statutorily required elements.

PA 14-163 requires that the State Water Plan identify, on a regional basin scale, the quantities and qualities of available water, both groundwater and surface water; the present and projected demands for such water; and recommendations on utilizing the state's water resources in a manner that balances competing uses, including public water supply, health,

economic, recreation and environmental benefits. In our review of other states' plans we learned that a less comprehensive initial approach could result in having to redo some of the process. For example, California initially focused only on surface water and later found they needed to go back and include groundwater.

In all reviewed state water plans, sound science and data provided the basis for developing a state water plan. Specifically, states with an effective state water plan include robust data at appropriate scales, an on-going commitment to fund data collection and analysis, and the flexibility and funding to collect additional data to address specific issues that arise.

In addition to a commitment to data collection and analysis, some states specified that models should be used as a tool to address specific questions and to fill gaps in the data TN used OASIS and STELLA. Some states specified what data and models were needed (like Massachusetts) while other states offered a more general statement of a commitment to science (like Georgia). Based on our review of other states' approaches, modeling for water planning should reflect the questions to be answered and the application scale (local, regional, basin size), and will depend on both the resolution and accuracy of the data available.

Water Planning Principle 3: Public and Stakeholder Process

A strong commitment to public process is critical to successful state water planning. Everyone uses water, and as a result, everyone has a role to play in water planning. Public outreach and public and stakeholder engagement together with on-going access to transparent, high quality information and communication contributes to a process that is perceived as legitimate. Ultimately, creating a legitimate planning process is fundamental to the successful adoption and implementation of a state water plan.

The state water planning process should include engaging stakeholders and the public to allow the plan to be shaped and informed by the expertise and needs of the community and to allow everyone to be informed of potential changes that may affect their interests. Public and stakeholder engagement processes can also help to minimize conflicts or provide space for resolving conflicts when they arise. All the states we reviewed made a commitment to engaging stakeholders and the public, many at two levels: 1) during the development of the plans and 2) as an essential component of the ongoing planning process.

In addition to public and community engagement, many of the states we reviewed formed stakeholder advisory and/or technical panels at both the state and local/regional levels. Typically, statewide advisory groups included elected officials and agency staff or liaisons and the local/regional advisory panels addressed the specific planning activities at a local or regional scale, -such as watersheds or use of HU (Hydrologic Unit) areas. For example, many states held regional workshops for planning and relied on regional stakeholder groups or committees. The make-up of the regional/basin committees varied from being highly political as in Georgia and Florida, with most of the positions comprised of elected officials and agency staff in ex-officio roles, to locally-determined membership tailored to the needs of the particular basin. In addition, some states, such as Nebraska, had "core" stakeholders as legislatively mandated

members with the remaining categories determined at the local or basin level. Lastly, some of the states required stakeholders to have certain professional qualifications and/or documented subject matter expertise.

Though Connecticut is smaller than some others states' regions, the Connecticut Water Plan should consider including public and stakeholder engagement at the two scales. The variability of terrain, climate, and natural characteristics, coupled with our locally-controlled political institutions and policy priorities, will all contribute to the development of tailored water management frameworks appropriate for the local/regional level.

PA 14-163 mandates that the Water Planning Council seek the involvement of interested parties and solicit input from the Advisory Group when developing a state water plan and further specifies a detailed process and timeframe for public review and comment prior to plan finalization. The Act does not appear to require ongoing involvement of the public through implementation. Our review suggests that outreach and engagement is especially important as the planning process becomes more local; a locally focused engagement process should be defined as the plan is developed.

Water Planning Principle 4: Integrated Approach

To account for the complexities of the human-hydrologic-ecologic water system, PA 14-163 directs the Water Planning Council to consider a range of factors including identifying quantities and quality of surface and groundwater for public water supply, health, economic, recreation, and environmental benefits while taking into account desired ecological, recreational, agricultural, industrial, and commercial use. Moreover, the Act links land use and development to water quality and quantity. Although the Act does not specifically mandate integration of these factors, our review of other states suggests that integration is essential to an effective state water plan.

Many of the states reviewed explicitly identified their plans as "integrated," however they defined integration and carried out integration differently. In some states, such as Oregon and Colorado "integration" meant treating water as an integrated resource by recognizing the physical connection between surface and groundwater, incorporating both water quality and quantity, and water withdrawals and discharges. In other state plans, such as Pennsylvania, economic and social factors related to water use were also integrated into their planning process. An effective Connecticut water plan should incorporate the full range of integration encompassing all the factors that affect water uses and users.

Water Planning Principle 5: Fair and Equitable Process for Balancing Values

Because water is a finite, non-substitutable resource an effective state water plan should include a process to facilitate a fair and equitable process for balancing values and resolving conflicts. This is particularly important for basins that may be or may become over-allocated, and where, during a drought or other water-supply emergency, there simply is not enough water to meet the in-stream and out-of-stream demands. Consistent with this principle, PA 14-163 includes a provision that the state water plan recommend the utilization of the state's

water resources, including surface and subsurface water, in a manner that balances public water supply, economic development, recreation and ecological health. Further, the Act requires that the WPC, in developing the state water plan, examine appropriate mechanisms for resolving conflicts related to implementation of the plan.

Our review of other states water planning processes suggests that most states recognize the need to balance competing water uses and provide mechanisms for negotiating values among different uses within the planning process. For example, states that specify broad stakeholder representation on state and regional/local advisory groups (inclusive of different water users including environmental groups) provide opportunities for resolving conflicts between uses and for negotiating different competing values. Other states, like Massachusetts, include the environment explicitly in their analysis of water quantity and quality.

While we found recognition of the need to balance different values, our review also showed the challenges inherent in achieving a fair and equitable balance of values in practice. On the one hand, even when participatory processes are designed to be broad and inclusive, it is possible not everyone involved will have the same influence on the outcome. For example, in Texas, while environmental groups were included in the regional/local planning process, conversations with participants in the planning process revealed that their concerns were not taken into account. On the other hand, even if the state emphasizes environmental values or the water needs of under-represented groups, there may be insufficient water available to meet those needs at all times.

Participatory planning processes that provide space for both articulating and balancing values are often instituted separately from the water allocation process and may be after water has been partially or fully allocated to other uses. The challenge becomes finding innovative ways to re-distribute water in a manner that reflects the changing priorities of different and sometimes competing values. That said, states like Oregon, appear to successfully use incentives for water conservation to re-distribute a portion of conserved water for the environment and other uses.

Ultimately, what these states' experiences suggest is that Connecticut must be vigilant in creating processes that enable the full range of interests to be represented in the planning process and to ensure that no one group dominates the process. This will ensure that the outcome reflects a shared vision at appropriate resource planning scales.

Water Planning Principle 6: On-going, Iterative Planning

When PA 14-163 revised Section 22a-352 of the general statutes, the long-standing requirement that Connecticut's state agencies "establish a continuing planning process and shall prepare and periodically update jointly a state-wide long-range plan" was deleted. In its stead, the legislature included a requirement that the "Water Planning Council shall oversee the implementation and periodic updates of the State Water Plan". Although the Act requires that the WPC oversee any plan updates, the frequency for doing so is undefined, as is the

process and planning horizon. As importantly, there is no longer the requirement that planning be “continuous”.

Although PA 14-163 does not expressly establish a continuing planning process nor a planning horizon, maintaining an ongoing, long-range planning effort is critical to ensure not only that investments in planning are not wasted, but also that the process is iterative to account for and respond to changing needs and conditions. It is not sufficient merely to invest in a single, static, long-range plan, though some states have adopted this approach. For example, we found several cases where state water planning was initiated, a planning infrastructure was developed, new information and data were generated to support the planning effort, and a state plan was produced. Unfortunately, once these states produced a plan, further planning activities stopped, stifling implementation of the plan. According to individuals familiar with those planning efforts, the lack of commitment to continuous planning also meant the plan and information contained in the plan rapidly became outdated and less useful for informing decision making.

With ongoing iterative planning whereby states continue to invest in the planning effort, information and data become more robust over time and the state is able to monitor changing conditions and make more informed decisions for managing water uses. Ongoing iterative planning also supports making incremental changes (e.g., to the planning process, management approach or to the regulatory or policy framework) if needed. Such ongoing, iterative planning will be critical, for example, to address changing demand patterns, new programs and policies taking effect, or the impacts of climate change. Figure 1 illustrates the feedbacks and steps in an example ongoing iterative planning process.

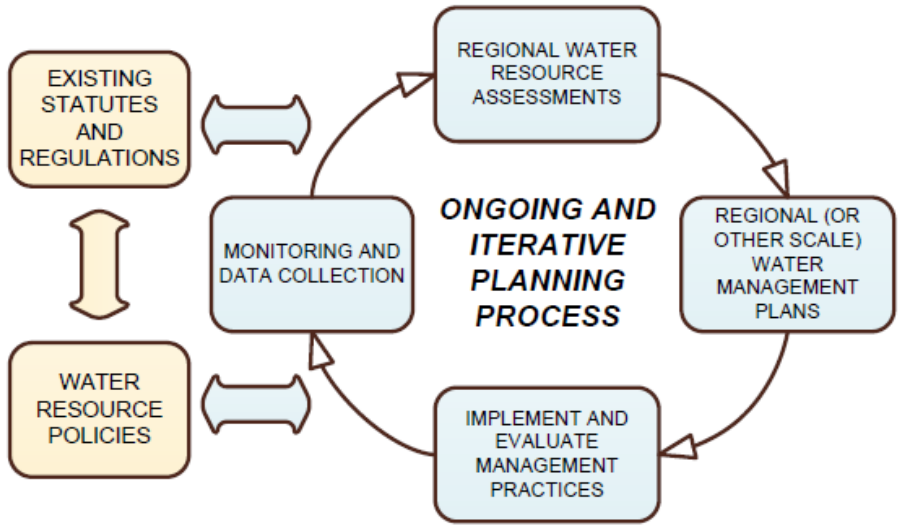


Figure 1. Example model showing an ongoing iterative planning process with feedbacks (thick arrows) between the regulatory and policy frames and between the regulatory and policy frames and the planning process. Adapted from the Georgia Water Council, Comprehensive State-wide Water Management Plan (2008) available at: http://www.georgiawatercouncil.org/Files_PDF/water_plan_20080109.pdf .

This diagram is very similar to one developed in 2002 by the Water Resource Management Subcommittee A, "Water Allocation," Workgroup of the WPC.

In states with ongoing, long-range planning that includes the production of a state water plan; plans typically have a 20 - 50 year planning horizon and are revised on 5-year cycles (e.g., California, Tennessee and Texas). Alternatively, Nebraska favors an ongoing planning process with an annual state water planning and review process and more detailed evaluations of individual basins every four years.

States that employ ongoing planning typically designate a responsible authority (e.g., a state water agency) that helps to guide and support the planning effort. As part of the initial planning process, the WPC should identify a recommended timeframe for plan updates, the mechanics for doing so, and ensure that planning remains an ongoing iterative process.

Water Planning Principle 7: Planning that Informs Policy and Legislative Change

PA 14-163 recognizes that feedbacks between planning and policy or legislative change are necessary to implement recommendations of the State Water Plan. While existing laws and regulations direct how we currently manage our water resources and will be part of the state water plan framework, the planning process will likely identify areas that could benefit from proposed policy or legislative changes. These feedbacks--between policy, legislation, and planning--are necessary to continuously advance the effectiveness of our water resource management efforts. Figure 1 illustrates the feedback relationships between policy, legislation and planning.

Comprehensive planning efforts will most likely always identify areas benefitting from a change – however subtle – in underlying law or regulation, and result in recommendations to affect those changes. What is important is that any such recommendations be thoroughly considered within the context of the plan itself. By committing to a cyclical planning effort (as in Planning Principle #5), the State Legislature will be getting a picture of water use and availability over time and of water issues that arise and worsen (or resolve). With a clear connection between planning and policy or legislative change, the state will be in a better position to systematically adapt their approach to managing this critical resource.

Other states require that their planning efforts inform and guide water policy and legislative changes. For example, in Texas, the planning process must develop legislative recommendations as part of the State Water Plan. These recommendations have resulted in important legislation ranging from new modeling efforts, to new water use reporting requirements, to a framework for groundwater management. Similarly, the Kansas Water Authority is tasked with recommending legislation, while the law authorizing Oregon's water strategy encourages participating agencies to identify legislative and budgetary needs as part of their work product. This explicit connection between planning and policy or legislative recommendations appears to be an important component of successful planning efforts that also advance water management.

Water Planning Principle 8: Conservation

A critical component of an effective state water plan is a commitment to water conservation, a reduction in lost water and inefficient use, and reuse where possible for non-potable uses. This is consistent with PA 14-163 that stresses the importance of water-resource stewardship and conservation, energy efficiency, and development of a water reuse policy with incentives for matching the quality of water to the use.

A theme common to almost every state water plan reviewed is sustainable water management, of which conservation is a major component. Many of the other state plans reviewed, including Massachusetts, consider "efficient" use of water to be a first step to offset projected withdrawal increases. Pennsylvania mandated creation of a Water Resources Technical Assistance Center to promote conservation and sustainable water management, although lack of funding prevented the Center from being established.

Conservation is particularly critical for basins that may be or may become over-allocated, and where, during a drought or other water-supply emergency, there simply is not enough water to meet the in-stream and out-of-stream demands. Florida, where over-allocation and overdrafts have caused land subsidence and drying of water bodies, has a process to close basins to additional withdrawals. In these areas, new users must find "new" or "alternative" water through conservation, reuse, or technologies like desalination. Frequently, the most effective means of conserving water is to limit outdoor water use. Florida also has a very well-developed "Florida-Friendly Landscaping" program. Oregon uses incentives to increase water conservation and redistribute a portion of the conserved water to benefit the environment.

Other states' plans include consumer conservation, reuse of water for non-potable purposes, low impact development and green infrastructure practices to allow for future development and sustainable water use without negative impacts on water resources. Connecticut should make this commitment in the early stages of water planning; an early investment in conservation will help lessen impacts of future water conflicts and support continued economic growth.

Water Planning Principle 9: Education

PA 14-163 outlines educational initiatives that are to be included in a State Water Plan, including keeping residents informed about the importance of water-resource stewardship and conservation; short and long-range objectives and strategies to communicate and implement the plan; and intra-regional solutions and sharing of water resources.

Many of the state plans reviewed included public education events such as public hearings, water forums, or outreach meetings specifically targeted to educate the general public, and in some states, such as Florida, middle school students. The size, format, and frequency of these events varied from state to state, but all were important to support plan development and implementation. Some states took an additional step; for example, Nebraska partnered with their University's Public Policy Center to conduct research to improve their outreach and

education efforts. Lastly, Pennsylvania established the Water Resources Technical Assistance Center to assist in promoting education and conservation.

Websites and print media are important tools for storing information and for sharing this information with the public. Websites can compile relevant information such as water use and availability data, mapping tools, and reporting and permitting information. Based on our review, websites with fresh, visually engaging content and consistently updated information were the most successful. For example, Pennsylvania's water website, including their water atlas, is visually interesting and contains an abundance of data, mapping tools, and a document library useful for engaging and informing the public. Finally, a number of states, including West Virginia, have public, web-based ArcGIS tools to display data layers relevant to water use.

As with other elements of water planning, a consistent, renewable source of funding is necessary to create and sustain educational programs. Many of the states under review contained language recommending increased funding for educational programs, but none of them outlined a dedicated funding source.

Based on our review, successful integration of educational strategies and programs into the on-going state water planning process engendered cooperation among stakeholders and support from an informed public. This cooperation and support is critical not only to the initial acceptance of a state water plan but also to the continuing momentum required in the future.

Key Elements of a State Water Plan

Box 2: Key Elements of a State Water Plan

1. State-level institutional and process elements
2. Regional/local water planning process elements
3. Water resource assessment elements

The OSPW workgroup identified key elements of a state water plan and planning process. What follows is a summary of the types of elements that emerged, and that are described in more detail in Table 1. The table lists detailed elements that are important to consider, concerns or cautionary thoughts on those elements (where they exist), and reference to one or more states that either demonstrate the importance of that element or the problems encountered if that issue is not addressed. The key elements below are based on information gleaned from review of other states' water plans and from individuals in those states who are familiar with the development and/or implementation of those plans.

1. State-level institutional and process elements

The OSPW workgroup recommends that statewide planning be conducted at two levels. The first level focuses on the roles and responsibilities of state entities and overarching statewide policies, and the second focuses on the ongoing water planning process at a regional, local, or basin scale.

1.1 Public Participation and Education. At both the state and regional/local levels, there should be broad public engagement and a strong outreach and education program that is accessible and geared to all.

1.2 Lead Agency. While most states conduct detailed planning at the regional level, they also designated a lead agency to shepherd the planning process in consultation with other state agencies.

1.3 Policy. The lead agency should set overarching policy and convey that policy to planning groups through guidance materials for effective regional and local water planning. The state should also develop policy that outlines under what conditions a basin would be deemed over-allocated and what further policies and procedures would apply once that determination is made.

1.4 Priority Setting and Conflict Resolution Process. Several states used a regional water planning process to help prevent water conflicts from arising and relied on litigation to resolve those that did. In other states, a specific conflict resolution process was developed.

1.5 Technical Support. In most states reviewed, state agencies were responsible for developing and maintaining the information and technical resources required by the state and regional planning processes. When issues involve more than one state agency, some states involve the Governor's Executive Office of Environmental Affairs to handle those issues.

1.6 Funding: Dedicated and Unsweepable. States whose water plans seem to be the most effective have developed dedicated sources of funding and established a prioritization process to make the most of that limited funding. The wide variety of approaches used is described in Appendix 2.

2. Regional / local water planning process elements

Regional/local planning elements were identified that deal with the scope of water planning and with the membership and authority invested in regional stakeholder groups and technical advisory groups.

2.1 Scope. Many states designed regional processes that are flexible enough to be tailored to local situations and also to accommodate new issues that emerge like climate change. In most of the states reviewed, the regional/local plans were based on hydrologic basins. In some states the borders of the planning regions may reflect the spatial scope of the particular water planning issue, cutting across political and basin boundaries as needed. Many (but not all) explicitly acknowledge the interconnected nature of surface and groundwater and also the multiple, competing demands on the resource. In some states regional water planning is done in conjunction with multiple statewide planning efforts such as economic development, water quality, public water supply, and instream flow planning.

2.2 Timing. Most states require the regional water planning processes to follow statewide guidance for planning horizons and for frequency of regional plan updates. While planning horizons vary considerably, many states require updates of the plans every 1-5 years.

2.3 Regional / Local Stakeholder Participation. Most states with effective water plans require that regional stakeholder groups play a meaningful role in decision making. However, the required composition of the groups and what entity is authorized to appoint the members varies greatly. In some states, ”core” members of the group are mandated by state policy, while the remaining members are determined at the local level and are chosen to address the local needs and issues. Some states require specific professional qualifications for some of the members of the group. Other membership requirements may be based on residency within the region. It seems a combination of professional qualifications and interest group representation is most effective.

3. Water resource assessment elements

A state water plan must consider both surface water and groundwater, be science based, and be supported by a strong data foundation that integrates current and future water supply, water use, quantity, quality, and biological integrity.

3.1 Assessment goals. Most state plans attempt to assess the status of their water resources and to identify critical planning areas within the state. Initial assessments are used as baselines to detect trends and emerging issues over time using ongoing monitoring programs, typically run by the U.S. Geological Survey. Several states’ plans mention concern about the impacts of climate change on water resources.

3.2 Assessment Units. Some states use Hydrologic Unit Code (HUC)-8 as an assessment unit; other states use a different spatial scale and scope such as a defined watershed, and sometimes tailor the spatial scope to the needs of a particular issue.

3.3 Data and Models. Most of the states with effective water plans developed comprehensive, statewide water data sets, often publically available on the Internet. In addition, some have a “water atlas” that synthesizes the data. Some states incorporate water use data and usage data at either on a local watershed basis or aggregated at a larger regional basin level. Aggregating data may have advantages for establishing baselines and documenting trends; however, given that Connecticut’s water withdrawals tend to be near or from headwater streams, with returns flows closer to river mouths, aggregating data at the basin level may mask impacts to the stressed middle portions of stream systems.

Many states have developed basin water budgets that identify instream flow needs and have used other models as tools to assess current conditions, predict future conditions, or to fill in data gaps.

3.4 Climate change. Several states have explicitly addressed assessing climate change impacts and adaptation in their water planning.

Connecticut Policy Considerations

Like many states, Connecticut has historically – or more recently – faced a number of topics that are perceived as so-called "third rail" policy issues. Stakeholders tend to have strong opinions regarding these policy issues, and, as such, their mere existence can lead to water management challenges. While several of the following policy considerations were identified by the Water Planning Council [in its RFP for facilitator services], others were added by the OSPW as it conducted its research. These are not the only policy questions facing Connecticut and the list is not intended to be exhaustive. The OSPW has not formulated an opinion on how these issues should be addressed, or even whether they need to be at this time. However, other states have addressed some of these, or related, issues and the approaches they developed may be instructive as Connecticut moves forward with its plan. The policy considerations are outlined below and detailed references to other states' approaches are listed in Table 2.

PC.1 Registered ("Grandfathered") Diversions. Should the State develop a policy identifying under what conditions it might be appropriate to revisit grandfathered diversion quantities and use, and what can be done to help incentivize that negotiation?

PC.2 Class A / Class B waters. Many states use what would be considered "Class B" water for public water supplies. Should Connecticut consider such a change in policy as a way to shift use from smaller, head-water basins to higher-flow downstream areas?

PC.3 State program administration. Connecticut water resource administration has long been criticized for being somewhat fragmented. As part of the state water planning process, should Connecticut seek to determine the most efficient way that overarching state responsibilities for water can be expressed in an administrative structure?

PC.4 FOI and water security. Water information security concerns were not typically addressed in other state plans. However, because water planning typically requires knowing the location, amount, and timing of water withdrawals, does Connecticut need to revise certain policies and procedures related to water company information to enable these data to be made available without jeopardizing public safety?

Model Table of Contents

State water planning documents vary widely in their scope and organization. While no particular state's plan emerged as a model that could be used in Connecticut, several organizational approaches had features that the workgroup believed could provide a clear sense of scope and purpose. The following is a draft model table of contents that serves to illustrate the best of these approaches in a way that might be useful for the Connecticut Plan.

Model Table of Contents

I. Terms and Acronyms

II. Executive Summary

III. Introduction, Vision Statement and Guiding Principles

A. Introduction

B. Vision Statement

C. Guiding Principles: In developing and executing the plan, the state is committed to the following:

- data collection and science-gathering on an ongoing basis;
- having an open, public process;
- a continuous, iterative planning process that allows for updating and revision in light of new problems and opportunities;
- integrating various needs, including public water supply, environmental, economic development, and recreation;
- driving necessary legislative change through the establishment of sound public policy – and vice-versa;
- funding on an ongoing basis;
- a fair and equitable process for balancing values;
- conservation; and
- education

IV. Current Condition Assessment

A. Understanding Connecticut's Physical Water Resources

i. Compile water resource data sources and information.
ii. Define and describe the various systems – surface and ground, including identification of the hydrologic boundaries of the major water sources within the state.

B. In-Stream and Out-of-Stream Needs

i. Assess how we use our water resources today – what, where, how and by whom?
ii. Quantify current water needs – consumptive and in-stream.

C. Resource Management

i. Evaluate current water management strategies, including regulatory programs.
ii. Identify data and other resource gaps necessary to provide an enhanced

understanding of water resources and needs.

D. Conflicts and Issues

V. Preparing for Change

A. Changing Demographics
- i. Estimate future trends in uses, including current and future capabilities of public water supply systems to provide adequate quantity and quality of water to their service areas.

B. Land Use Impacts
- i. Identify the effect various developmental scenarios and land use practices have on water quality and quantity.

C. Climate Change
- i. Evaluate climate-related impacts to water resources, uses, etc.

VI. Implementation: Meeting In-Stream and Out-of-Stream Needs

A. Funding needs and Strategies
- i. Identify broad-based funding mechanism that is relatively stable and that apportions program costs in an equitable manner.

B. Stakeholder Involvement

C. Conflict Resolution
- i. Identify strategies to mitigate conflict, including, where appropriate, incentives for impacted stakeholders to move from status quo.

D. Education and Outreach

E. Conservation

F. Measuring Success
- i. Identify specific metrics against which implementation can be gaged.

VII. Conclusions

A. Recommendations and Next Steps
- i. Establish a set of recommended goals for the use, management, and protection of the waters of the state and related land resource, with evaluations of alternative recommendations according to economic, environmental, hydrologic, jurisdictional, legal, social, and other relevant factors.
- ii. Identify timeframe for next plan update.

VIII. Appendix

Tables

Table 1. Key Elements of a State Water Plan

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Table 1. Key Elements of a State Water Plan

The table below lists elements of other state water plans that the OSPW members deemed to be relevant to the Connecticut effort. The center column lists comments, including concerns, caveats, and differences of opinion that emerged within the group. The column on the right gives references to specifics in state plans as examples. The numbering in the table matches the numbering in the text.

1. Institutional and Organizational Elements

    1.1. Public Participation and Education
    1.2. Lead Agency
    1.3. Policy
    1.4. Priority Setting and Conflict Resolution
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    3.2. Assessment Unit
    3.3. Data and Models
    3.4. Climate Change

Recommendation	Notes	References
1. Institutional and Organizational Elements		
1.1. Public Participation and Education. Develop strong public outreach and education components including comprehensive website with ALL information; workshops; listening sessions; strong, succinct visuals	FL: Water Management Districts have visually attractive, well organized website. Water use and resource data are available on line. Has developed extensive education programs targeted to school children. NE – Great newsletter, "Water Matters" that is truly informative, not just PR. This first issue explains their whole process really well. MA: Planning data available through GIS based application and permitting tool PA – Created a strong visual website, with a very popular Water Atlas and Touchstone Document to inform the public. NE: Publications of newsletters and general public information WV: Development of internet based database, and ability to access interactive data and report information. Includes interactive on-line GIS tool.	FL-1.1 http://floridaswater.com PA-1.1 http://www.pawaterplan.dep.state.pa.us/StateWaterPlan/docroot/Default.aspx NE-1.1 http://www.dnr.ne.gov/iwm/water-matters-1
1.2 LEAD AGENCY. Designate a lead agency/entity to advocate for and shepherd the planning process	RI: Division of Planning/Water Resources Board MN: Water Res. Ctr @ U of MN; CA: Dept. of Water Res. FL: Dept. of Environmental Protection MA: municipalities responsible for both economic growth and water supply and planning MA: when permits involve multiple agencies, coordinate through	FL-1.2 http://www.dep.state.fl.us/water/ PA-1.2 (Statewide Water Resources Committee/Final Bylaws05-10-04) http://wrc.umn.edu/watersustainabilityframework/

	EOEA (exec. office of environmental affairs PA - Although the PA DEP holds ultimate authority, the Statewide Water Planning Committee is the driving force behind PA water planning. The Committee's The Committee is responsible for collaborating with Regional Committees, the public and PA DEP to develop a plan and submit policy recommendations and guidelines. WV: West Virginia Leg established the WVDEP Water Resources Unit as lead agency for implementing the requirements of established Legislative Act NE: Merged 2 State Agencies to implement a collaborative planning process. TN - The Tennessee Department of Environment and Conservation is the approving authority and will serve as the lead agency for plan review.	TN-1.2 Page 2, http://www.tn.gov/environment/water/docs/regionalplanning/regional-water-supply-plan-approval-process.pdf
1.3 POLICY. Establish broad policy and overall framework for policy and planning at the state and local scale	RI: 2030 Water Plan NE: has a clear administrative structure WA: max net benefit for all people WA: Nat'l env protected and enhanced; overriding public interest to not do so WA: Wastes receive max treatment WA: review all statutes, recommend modification to legislature WA: consider economic and social consequences MA: developed overall water policy than modified regulations. simplify regulatory review, more predictable	NE-1.3 http://www.dnr.ne.gov/iwm/statewide-water-planning GA-1.3 http://www.georgiawaterplanning.org/pages/more_information/state_water_plan.php

	FL: Overall framework & polices established at state level; 5 Water Management Districts oversee and implement at a regional scale; Actions evaluated and assessed on a watershed scale appropriate to the issue. GA: Overall Water Plan framework set for/by State; Regional water planning councils set local priorities.	
1.3.1 Guidance on how to determine whether a basin is over allocated	FL: Has a system to establish "reservations from use" to preserve / protect both ground water and surface water resources. Also have "Surface Water Improvement and Management" planning process to protect & restore water quality and fish & wildlife habitat in priority watersheds. RI: Scituate system NE has developed specific criteria, scientifically based, that apply statewide. MA: Developed basin safe yield as a desired cap on withdrawals PA- Critical Water Planning Areas.	FL-1.3.1 http://www.dep.state.fl.us/water/waterpolicy/docs/factsheets/wrfss-water-reservations.pdf Example SWIM: http://www.nwfwater.com/water-resources/swim/perdido/ NE-1.3.1 http://www.dnr.ne.gov/iwm/water-matters-3 PA-1.3.1a § 3112(a)(6), § 3112(d), § 3113(c)(4)-3.1.2a http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220 PA -1.3.1b (pg. 70-71) http://www.pawaterplan.dep.state.pa.us/docs/Publications/3010-BK-DEP4222.pdf
1.3.2 Guidance on what procedures should be followed if a basin is determined to be over allocated	FL: Can establish reservation from use, minimum flows (surface water) or minimum levels (groundwater). RI: address summer use (watering) WA: conservation (rate structure), efficiency (consolidation), reclaimed water (streamline permitting) FL: Example SWIM: PA- Critical Water Planning Areas	FL-1.3.2a http://www.dep.state.fl.us/water/waterpolicy/docs/factsheets/wrfss-water-reservations.pdf FL-1.3.2b http://www.nwfwater.com/water-resources/swim/perdido/ PA-1.3.2a § 3112(a)(6), § 3112(d), § 3113(c)(4)-3.1.2a http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220 PA-1.3.2b (pg. 70-71)

	NE – in basins that are over or fully appropriated, there may be a moratorium on new withdrawals and planning will focus on how to address deficits, beginning with streamflow deficits. Also, in the Central Platte, they developed water banks and the state bought out some rights and kept them in the bank for potential future use. TN – relied on the concept of conservation and demand management, regionalization or water sharing among utilities, and development of new sources.	http://www.pawaterplan.dep.state.pa.us/docs/Publications/3010-BK-DEP4222.pdf NE-1.3.2a http://www.dnr.ne.gov/iwm/water-matters-1 NE-1.3.2b http://www.dnr.ne.gov/iwm/2012-integrated-management-plan-5-21-2012 TN 1.3.2 Page 33, http://www.tn.gov/environment/water/docs/regionalplanning/ncrwrps2011.pdf
1.3.3 Develop mechanisms to encourage water conservation and wise use	FL – focus is on local water use, and they discourage transport of water across county lines. In over-allocated areas then, the only sources of "new" water are conservation, re-use and alternate sources of water (like desalination), so these are critical components of the plan. MA: Encourage demand management as first step towards offsetting projected withdrawal increases MA: ID experiencing growth pressure and direct growth away from these areas or develop regional water systems NE – Conservation approaches must be considered as part of the IMPs PA –In addition to promoting broad conservation measures and management techniques, PA 220 requires PA DEP to establish a Water Resource Technical Assistance Center to provide technical assistance and promote conservation and water use efficiency practices. Lack of funding has prevented the Water Resource Technical Assistance Center from providing the level of service	NE-1.3.3 http://www.dnr.ne.gov/iwm/title-454-chapter-13-integrated-management-plans PA§ 3120 http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220

	intended. WV: Conservation practices underway and those to be implemented span many uses (rec, ag, public use) based on Large Quantity Use-types	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf (pg. 220)
1.3.4 Develop mechanisms to encourage water reuse for non-potable purposes	FL: Again, evaluation of re-use for non-potable purposes is a critical first step in considering additional water withdrawals.	
1.3.5 Establish prioritization process to make the most of limited funding	FL: Uses a priority listing system to identify systems for which "minimum flows and levels" (MFLs) must be established to protect the resource. Each water management district submits a priority list and schedule for establishing MFLs, focusing monitoring and modeling on the priority waters.	FL: http://www.nwfwater.com/water-resources/minimum-flows-levels/
1.4 PRIORITY SETTING AND CONFLICT RESOLUTION PROCESS	FL: Priorities are set by each Water Management District and often focus on basins where there are use conflicts. If water users are unhappy with the outcome, it goes up to the Governor level. NE – Groundwater Act of 2014 specifies that the DNR, the NRDs and surface water project sponsors need to "cooperate" to work out conflicts. and that an "Interrelate Water Review Board" is needed to resolve conflicts between the DNR and the NRDs; that the NRDs are the preferred entities to regulate groundwater.	NE-1.4 http://www.dnr.ne.gov/iwm/ground-water-management-and-protection-act-2014
1.5 TECHNICAL SUPPORT. Develop and maintain information and technical resources required by the state and regional planning processes.	FL: The Water Management Districts that oversee implementation of FL's water plan are large entities, on the order of 100 employees, including hydrologists, hydrogeologists, planner, engineers, land managers, biologists, foresters, computer anlaysts, technicians, with steady funding to support the districts, data collection networks and websites to share the data and programs.	

1.6 FUNDING. Create a dedicated, unsweepable water planning account (e.g., user, data access, permit, registration fees, or violation penalties, taxes)	GA: Georgia's water plan funding has been uneven; $1 million for state plan, $30 million for regional plans, and currently $1 million for plan revisions/updates. However secure steady funding is not part of the planning process and so momentum is lost when little or no funding to move ahead. FL: uses combination of property taxes, documentary stamp taxes, and special revenue funds to support established, staffed regional Water Management Districts; NH: identified data and needs and started the water plan process, but currently has no funding to continue the process, so the plan is on hold. WA & RI: surcharge on water use MN: special fund from part of sales tax for 25 yrs CA: through state appropriation WA: priority to current needs > new requirements; WA: explore alternative financing, grants, etc. MA: encourage enterprise accounts for O&M, stormwater mitigation, etc. MA: incentives to implement programs, grants, bond, possibly use scoring system—extra points for biological integrity CO: The CO Water Cons. Bd. Is almost fully self-funded, receiving no money from the Gen. Fund. The majority of funding appropriations comes from the CWCB Construction Fund. The Draft Plan also lists many potential funding sources WV : Joint Legislative Oversight Commission on Water Resources authorized funding of a DEP Water Resources Unit to implement State Water Resources & Protection Act.	GA-1.6 G. Luccina pers communication with Gail Cowie, Feb 26, 2015 and M. Smith pers Communication with Larry McSwain, March 6, 2015. FL-1.6 http://www.dep.state.fl.us/secretary/watman/wmd_budget.htm CO-1.4a http://cwcb.state.co.us/about-us/about-the-cwcb/Pages/main.aspx CO-1.4b http://www.coloradowaterplan.com/ chapter 6 MN http://www.wrc.umn.edu/publications/minnegram/fall-2013/mn-water-sustainability-report http://www.coloradowaterplan.com/

2.0 Regional/Local Water Planning Process Elements.	**MA: huge effort to avoid problems through planning; inducements to minimize stress in basin** **MA: create coordinated process with single application, ombudsmen** **NE: formed Water Policy Task Force to discuss integrated management of surface & groundwater; make recommendation on policy changes. Formed an Integrated Water Management Division.** **WV: cooperated in 9 state water resource study promoting broad policy integration** **NE – it's a PROCESS, not a statewide water plan.** **TN - developed "key elements" for their study areas**	**NENE-2.0 See this article: http://www.kearneyhub.com/news/agriculture/focusing-on-water-plans/article_e7e2f846-771b-11e4-b6de-37f2fe64fbf0.html** **http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Pages/default.aspx (Appendix H)** **http://www.tn.gov/environment/water/docs/regionalplanning/1_Elements_Regional_Plan.pdf**
2.1 SCOPE		
2.1.1 LOCAL ISSUES. The process facilitate tailoring plans to regional/local issues	A regional entity may not be needed because CT is relatively small. May want to consider State-wide framework and then local assessment unit processes that have local stakeholder input and flexibility to address the pressing issues within that assessment unit. FL: The Water Management Districts prioritize their focus and efforts through a yearly strategic plan that allows them to identify issues and the appropriate scale and local entities necessary to address them. GA: Regional water planning councils designate their own high priority items, PA: Regional Committees are responsible for coordinating local and regional interest groups, and determining priorities to influence	GA-2.1.1 Table 6-1 in in Lower Flint-Ochlockonee Regional Plan (2011)http://www.flintochlockonee.org/documents/LFO_Adopted_RWP.pdf PA § 3112(a)(6), § 3112(d), § 3113(c)(4)http://www.legis.state.pa.us/cfdocs/legis/li/consCheck.cfm?yr=2002&sessInd=0&act=220

	policy decisions at the state level. Guided by Regional Committees the SWP requires the identification of Critical Water Planning Areas comprising any significant hydrologic unit where existing or future demands exceed or threaten to exceed available resources. VA: Local & regional plans done first and submitted to Water Control Board for use in preparing state water plan. WV: Critical Planning Areas process to facilitate region specific efforts.	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Pages/default.aspx (pg. 235)
2.1.2 EMERGING ISSUES. Create flexible approach that allows incorporation of emerging issues and incremental improvements over time	i.e. the water plan should not be a static document. We need to be able to incorporate emerging issues like climate change as we learn more FL: The Districts complete an update to their overall Water Management Plan every five years, but through a yearly stratic plan, they can set priorities, refine efforts and incorporate emerging issues. . MA: requirements different based on baseline volumes and degree of flow alteration in the basin PA – The SWP was designed to be updated in 5 year increments with an emphasis on input from Regional Committees in order to address changing topics and expand previously identified priorities. The SWP has already missed its first planned update. NE – annual assessment of conditions, and clearly stated triggers for mandatory plans.	NENE-2.1.2 http://www.dnr.ne.gov/iwm/water-matters-1 PA - http://www.pawaterplan.dep.state.pa.us/docs/Publications/3010-BK-DEP4222.pdfhttp://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220
2.1.3 Integrated planning	Quantity KS: Efficient use a priority (likely driven in part by allocation scheme). MA: Quantity: Demand management required to minimize impacts	

	Increase treated wastewater recharge and reuse (on crops, recreational areas and aquaculture). Require communities meet all existing conservation standards before proposing a new source. First source is conservation, second is recharge and reuse of water. Source options should include flood skimming, desalination, regional supplies, and interbasin transfers. New Hampshire: OR: Makes good use of incentives. PA: Along with the 8 recommendations included in the State Water Plan, DEP is also charged with implementing a Water Resources Technical Assistance Center to promote water conservation and efficiency. WV: Instream flow needs for water quality are factored into the water budget. Quality GA: EPD implements water quality management policy through its current statutory authority and rules concerning water quality stds,, controlling water pollution and issuing discharge permits. The actions the EPD will take are listed on p. 16 of the plan. GA will manage point and non-point source pollution on a watershed basis to provide for the protection of water quality, the restoration of impaired waters and the management of assimilative capacity for current and future uses and users. KS: Act provides for protection and improvement of water quality and prevention of pollution to waters. CWA primary tool along with Water Restoration and Protection Strategy and nutrient reduction plan. MA Preventing and protecting are stressed. Requirements for planning of development and consideration of LID. MI: The 2010 Minnesota Water Plan primarily focuses on water	

	quality. Some points of interest: DNR by statute conducts an assessment of water use and availability on a five-year basis, with the goal of a status on availability and trends in water appropriations (i.e. withdrawals) and (available?) water resources. Conclusions from the 2010 report include: • Water is being consumed faster than it can be replenished; • Land use choices that are made without proper planning and protective practices are degrading water supplies; and • The natural landscape has been changed so greatly that the ecosystems that remain are no longer able to provide essential cleansing and recharge functions NE: Let watersheds set their own definition New Hampshire: OR: Integrated with Federal Clean Water Act, Oregon Ag. Water Quality Management Act, Forest Practices Act and Groundwater Quality Protection Act. PA: PA has had a fragmented approach. The SWP calls for: "An integrated approach to comprehensive water use planning will account for all the water users and dischargers in a watershed, will provide for the proper siting of those users, will protect sensitive areas, and will provide long term assurance that both water quantity and quality will be maintained for future generations." Texas: VA: Water quality issues are addressed in the most recent DEQ biennial Water Quality Assessment Integrated Report.	

	West Virginia: Surface and Groundwater Withdrawals and Discharges Competing needs and demands (economic development)	
2.1.4 Develop guidance on developing measures of sustainability at the regional level	MN: water quality connected Ag in MN River addressed as issue; modeling mentioned NE – this is the first step in the planning process. stakeholders actively help define the goals and objectives. Later, public hearings are held. http://www.dnr.ne.gov/iwm/water-matters-1 WA: use penalties, incentives, regulation WA: emphasis on reclaimed water where possible WA: Withdraw waters from development that don't have adequate info available	
2.2 TIMING		
2.2.1 Define a planning horizon	CA: CA's Sustainable Groundwater Management Act of 2014 has too long a planning horizon; plans due to be adopted by 2022 and sustainability isn't mandated for regions until 2044. Many GW supplies are estimated to be exhausted in a year at current usage during the current drought emergency. Many states use 20 or 50 year horizons for planning CT Water Supply Plans have 20 and 50-year planning horizons	CA-2.2.1 http://www.latimes.com/opinion/op-ed/la-oe-famiglietti-drought-california-20150313-story.html NE-2.2.1 http://www.dnr.ne.gov/iwm/2012-integrated-management-plan-5-21-2012

	FL; 20 years MN: 10 & 25 yr framework w/3 phases; MA: 20 years WV: out to 2040 NE – in the Central Platte plan, the tasks for remediation of the over-allocated condition had a 10-year plan.	http://wrc.umn.edu/watersustainabilityframework/
2.2.2 Define how often plans should be updated	FL conducts 5-year updates, but also incorporates updates in the yearly strategic plans for each Water Management District CT Water Supply Plans updates required every 6 to 9 years GA& CA: 5 yrs PA - 5 year increments. NE: Basins review and updates work on a four year work projection TN - WPC monitors, analyses, and reports on the quality of water in Tennessee on an annual basis, and it oversees the five-year water quality planning cycle for each of Tennessee's 55areas.	GA-2.2.2 http://www.nwfwater.com/data-publications/reports-plans/consolidated-annual-reports/ PA § 3111(a) http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220 Page 27 http://www.tn.gov/tacir/PDF_FILES/Other_Issues/Statewide_Water_Resources.pdf
2.3 REGIONAL STAKEHOLDERS		
2.3.1 ROLE. Facilitate broad stakeholder engagement and meaningful participation	CA: 28 agency etc. steering comm + advisory commNE – the "District Stakeholders Group" (people who rely on the water in that area, including environmental) is listed as one of the formal "authorities" under which the plan was developed. (Central Platte Plan) MA: Multi-stakeholder steering and technical committees. Public comment period.	CA-2.3.1 http://www.dnr.ne.gov/iwm/2012-integrated-management-plan-5-21-2012 PA (pg. 1) http://www.pawaterplan.dep.state.pa.us/docs/Publications/3010-BK-DEP4227.pdf

	PA – Prior to the adoption of PA 220, PA DEP hosted 16 water forums to gather public support and input for a SWP, and help guide the composition of the Statewide and Regional Committees.Section 2.3.2 WV – Local meetings organized by HUC-8 areas	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf (introduction)
2.3.2 COMPOSITION. Stakeholder group composition should reflect the full range of interests and values within the a management plan's affected area	CA: based on CA Water Code including conservation and reuse RI: Water Use and Efficiency Act; gives data showing low use per capita vs other states NE – by statute the NRDs specifies a list of water industry and municipality reps then says "and with other water users and stakeholders as deemed appropriate by the department or by the affected natural resources districts. They shall also actively solicit public comments and opinions through public meetings and other means." NOT to be emulated – we need to specify a fair representation of values. GA: Regional water planning councils all political appointees, shortchanging environmental and conservation concerns FL: governor appoints Governing board of the Water Management Districts – only requirements are residence within that district and "significant experience" in ag; development; local government; water utilities … So these are very political appointments and the distribution of stakeholders across the interest groups is not consistent. PA – Statewide and Regional Committees consist of stakeholders from a variety of backgrounds. See Section 2.3.3. VA- Governor appointed 7-member State Water Control Board TN – In Both Study Areas the advisory group the composition was identical, though the contributors to the two studies were slightly	NE-2.3.2 http://nebraskalegislature.gov/laws/statutes.php?statute=46-717 http://www.planning.ri.gov/documents/guide_plan/RI%20Water%202030_06.14.12_Final.pdf GA-2.3.2 M. Smith pers communication with Larry McSwain, March 6, 2015

	different	http://www.tn.gov/environment/water/docs/regionalplanning/wrtac_roster_01-04-13.pdf pg3 http://www.tn.gov/environment/water/docs/regionalplanning/ncrwrps2011.pdf
2.3.3 SELECTION. Specify the types of stakeholders that must be at the table	[This and COMPOSITION need reworking – PAB] PACA & MN: long lists of participants in planning process PA: Statewide Committee consists of 18 appointed members as follows: six from the Regional Committees; six representing a cross section of water user interests including agriculture, conservation districts, industrial and commercial enterprises, mining, energy development and production and public water supply; six representing local government, environmental and conservation interests and professions relating to water resources management. The Governor shall seek from representative organizations. Members serve terms between 2 and 4 years. (PA § 3114) Regional Committees consist of 17 appointed members consisting of 2 from agriculture; 1 from a residential water supply agency; 1 from public wastewater; 3 from significant industrial and commercial enterprises, energy development and production interests; 3 from environmental/conservation; 4 with education and experience in professions relating to water resources management, including engineering, hydrology, geology, planning, law and economics, one of whom shall be a registered professional geologist; 3 from local government; 1 department employee. Terms range from 1- 3 years. (PA) NE: Extensive public hearing process, formal stakeholder participation. Publication of newsletters and informative material. WV: Stakeholder meetings based on HUC-8 areas held in centralized	PA § 3114, § 3113http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220 http://dnr.nebraska.gov/iwm/statewide-water-planning

	locations. Included state agencies, county . TN - 69-7-309. Technical advisory committee. The commissioner shall appoint a technical advisory committee, the number of members to be determined by the commissioner, that shall advise the commissioner on the status of the state's water resources and future planning efforts. The technical advisory committee shall be composed of representatives of federal, state, and local agencies and of appropriate private organizations, including not for profit organizations, commissioners, elected officials, watershed associations, economic development council members, city planners & engineers, flood plain managers, & "Large Quantity Users"	TN - Pg. 30, http://www.tn.gov/environment/water/docs/regionalplanning/regional_water_resources_planning_guidelines.pdf
3.0 Key Components of Water Resource Assessment.		
3.1 Assessment Goals		
3.1.1 Basin Water Budget. Develop a water budget in each assessment unit, treating water as an integrated resource * both surface and groundwater * withdrawals and return flows * consider water quality	Some states started with just surface water planning, and are now going back to add the ground water component. Since ground water and surface water are two parts of the same resource here in the humid East, the water plan needs to encompass both. (Also, the legislation requires consideration of both). FL: Treat groundwater and surface water as integrated resource. Use a water budget approach for assessing basins. RI: addresses large surface and some groundwater based systems; MN: both ground and surface addressed NE – data to be used is specified in the regs, more hydrologically detailed than the CT:	NE-3.1a http://www.dnr.ne.gov/iwm/title-454-chapter-13-integrated-management-plans NE-3.1b (summary of metrics) http://www.dnr.ne.gov/iwm/water-matters-3 NE-3.1c (annual assessment) http://www.dnr.ne.gov/iwm/2015-report-summary-and-table-of-contents http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf (Chapter 3)

	NH: Assessment of water uses and resources using a water budget approach. WV: models or "water budgets" were created using rainfall totals over the past 30 years. Models were used to calculate the water coming into the state and flows leaving. This method has a high percentage of errors because values were estimated.	
3.1.2 Critical areas. Identify critical areas /priority sub-basins or regions	FL: Have a prioritization process for what basins to address next and what tools to use, depending upon analysis of resources and existing and proposed uses and where conflicts may occur. RI: Scituate Reservoir system (Providence) WV: Developed an application process to determine Critical Planning Areas and evaluation criteria process MA: Prioritized basins based on degree of biological and flow alteration. PA –Allow for the identification of regions of stress, and designate Critical Water Planning Areas,to be identified and included in the statewide conversation and influence policy recommendations.	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Pages/default.aspx (Chapter 6) § PA§ 3112(a)(6), § 3112(d), § 3113(c)(4)- http://www.legis.state.pa.us/cfdocs/legis/li/uconsCheck.cfm?yr=2002&sessInd=0&act=220
3.1.3 Establish a baseline and detect trends and emerging issues	Both establishing a baseline and detecting trends requires a strong, on-going monitoring program that has some ability to change over time to address specific issues. FL: Water Management Districts have steady funding for their monitoring programs and can collect additional data where needed to address specific resource issues. Wide range of types of data collected, including stream flow, ground water levels, water quality, and water usage data. All are available through GIS mapping applications. RI: data by region provided WV-Data on water use by basin and type of use for Large Quantity	FL-3.1.3 http://www.dep.state.fl.us/water/datacentral/index.htm RI-3.1.3 http://www.nwfwater.com/data-publications/hydrologic-data/ NE-3.1.3 http://www.dnr.ne.gov/iwm/2012-integrated-management-plan-5-21-2012 http://www.planning.ri.gov/documents/guide_plan/RI%20Water%202030_06.14.12_Final.pdf

	User VA-Water withdrawals by basin and use updated annually in annual report RI: has some trend data on use NE – In the Central Platte plan, the NRDs are responsible for tracking and reporting water use.	http://www.planning.ri.gov/documents/guide_plan/RI%20Water%202030_06.14.12_Final.pdf
3.1.4 Do periodic re-assessment	FL: Collect data on both existing conditions and trends VA: Water withdrawals updated annually WV: Water withdrawal projections by HUC-8 watershed for 2020,2030, & 2040 NE: requires annual assessment of each basin to see if conditions have changed. If conditions have not changed in 4 years, a deeper level of evaluation is done, possibly re-doing the plan.	NE-3.1.4 http://www.dnr.ne.gov/iwm/2015-report-summary-and-table-of-contents
3.2 Assessment Unit. Employ a watershed-based unit.	The critical recommendation is that a watershed unit needs to be used for assessments (vs. county or municipality). HUC 8 scale areas might be appropriate to do a state-wide screening, but we want to allow flexibility in using larger or smaller watershed scales to address specific issues. Watersheds should be defined by USGS gage locations in order to accurately perform water budgets. Note also that some data, like Ag data and census data are generally compiled on a county basis, so it may make sense to evaluate water use data on a county basis. FL uses different boundaries for different purposes, depending on the issue of concern and data that goes into the analysis. GA: water planning regions were a combination of HUC-8 units adjusted by political boundaries MA: sub-basin scale(HUC-12); keep water local and live within	GA-3.2 (M. Smith pers communication with Larry McSwain, March 6, 2015)

	budget; demand management WV: HUC-8 planning unit. Water budgets developed for each. TN – The programs noted above and other federally delegated programs are administered by one of TDEC's three water-related divisions: WPC monitors, analyses, and reports on the quality of water in Tennessee on an annual basis, and it oversees the five-year water quality planning cycle for each of Tennessee's 55 HUC-8 areas. (Called HUC-8 for short, an eight-digit level of the Hydrologic Unit Code established by the U.S. Geological Survey.	TN 3.2 Page 27, http://www.tn.gov/tacir/PDF_FILES/Other_Issues/Statewide_Water_Resources.pdf
3.3 Data and Models		
3.3.1 Establish strong data foundation (e.g., a water atlas) and make this information transparent to the public	Provide transparency without compromising security of public water supply systems. VA and WV plans aggregate water use data by HUC-8 area and use. FL: Makes data available online through GIS mapping application. NH: has a great "Water Resources Primer" WA: one system with all relevant data MA: USGS seasonal streamflow criteria guide permitting decisions MA: use best available science GA: has a nice Water Planning website; However, it was initially set up by a consultant and the transfer back to state control has not been smooth PA Created and maintains an interactive, data-driven website. Published and distributes a popular Water Atlas, and Touchstone Documents. In cooperation with USGS, created a water-analysis screening tool (WAST) to assist in the identification of critical water-planning areas. NE: Developed an integrated, user friendly, information database	FL-3.3.1 http://www.dep.state.fl.us/water/datacentral/index.htm NH-3.3.1 http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm GA-3.3.1a http://www.georgiawaterplanning.org/ GA-3.3.1b G. Luccina pers. communication with Gail Cowie, Feb 26, 2015 PA- http://www.pawaterplan.dep.state.pa.us/statewaterplan/docroot/default.aspx http://pubs.usgs.gov/of/2008/1106/ NE-3.3.1 http://www.dnr.ne.gov/insight/

	available to public on internet website NE – online "INSIGHT": WV-Online ArcGIS tool with water resource information and data. Development of internet based database, and ability to access interactive data and report information. Includes interactive on-line	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Pages/default.aspx (Appendix B)
3.3.2 Identify gaps in data, knowledge, and strategies for addressing those gaps	OR	
3.4 Climate Change	GA: Georgia's water plans do not address climate change. NE: "Nebraska has yet to begin planning for climate change impacts on a broad scale. Statewide or agency-level adaptation planning currently under way is focused almost exclusively on wildlife." WV: Mechanisms being used by local governments to prepare for climate change include: land-use planning; provisions to protect infrastructure and ecosystems; regulations related to the design and construction of buildings, road, and bridges; and preparation for emergency response and recovery CA, MN, RI: mentions & states need to consider	

Table 2. Selected Policy Considerations for Connecticut

The table below lists some Connecticut – specific water policy issues along with references to how other states have dealt with similar issues.

PI.1. Registered (a.k.a. "Grandfathered") Diversions.

PI.2 Class A / Class B Waters

PI.3 State Program

PI.4 FOI and Water Security

Recommendation	Notes	References
PI.1 Registered (a.k.a. "Grandfathered") Diversions	FL: Allowed existing uses (at the time the permit system came into effect) two years to come in for a permit, subject to a test of "reasonable-beneficial use".	
PI.1.1 Recommend reporting requirements for grandfathered diversions	WA: use it or lose it WV- Reporting requirements for: Large Quantity Users (>750 MG,000 gallons/month) required to register with DEP96 VA- Annual reporting for withdrawals >10,000 gpd in any month, lesser requirements for agriculture	http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf

PI.1.2 Determine under what conditions it might be appropriate to renegotiate grandfathered diversion amounts	NE WA KS	
PI.1.3 Investigate how renegotiation of grandfathered diversions could be incentivized	OR NE WA KS (check reference).	
PI.2 Class A / Class B Waters. Most states do not prohibit the use of what CT considers "Class B" water.	Most states do not prohibit the use of what CT considers "Class B" water RI- Laws and regulations restricting sewage and wastewater discharges to public drinking water supply sources (subject to treatment) sources MN – Statute prohibiting discharges of sewage and other matter that may impair the healthfulness of water bodies used as a source of water supply for domestic usecourse) . RI, MN allow the use of treated water .water bodies used as a source of water supply for domestic use.	http://law.justia.com/codes/rhode-island/2013/title-46/chapter-46-14/section-46-14-1) http://www.dem.ri.gov/pubs/regs/regs/water/h20q09a.pdf https://www.revisor.mn.gov/statutes/?id=144.35
PI.3 State program. Determine the most efficient way that the overarching state responsibilities for water can be expressed in administrative structure.	WA: for each recommendation had 1)background, 2)timeframe; 3) lead implementing agency; 4) supporting agencies; 5) task description identifying steps; 6) potential funding sources NE: Merged 2 State Agencies to implement a collaborative planning process	http://dnr.nebraska.gov/iwm/statewide-water-planning (History of Water Management)
PI.4 FOI and water security	WV- State water plan enabling legislation includes provisions to protect confidentiality of trade secrets, homeland security, & other	Water Resources Protection Act §22-26-4 http://www.legis.state.wv.us/wvcode/ChapterEntire.cfm?c

FOI exemptions, including information that if made public would "present a threat to the safety and security of any water supply"	hap=22&art=26

APPENDIX C
Data Quality Plan

Section 1. Project Management

1.1 Title & Approvals

Quality Assurance Project Plan (QAPP) for:
Connecticut State Water Plan

Prepared by:

CDM Smith
111 Founders Plaza
Suite 1600
East Hartford, CT 06108

Approved:

Michael Jennings, NEIWPCC Quality Assurance Program Manager — Date: 8/2/16

Betsey Wingfield,
Connecticut Department of Energy & Environmental Protection (DEEP) — Date

Lori Mathieu, Connecticut Department of Public Health (DPH) — Date

Kirk Westphal, CDM Smith Project Manager — Date

David Polcari, CDM Smith QA/QC Manager — Date

Section 1. Project Management

1.1 Title & Approvals

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Connecticut State Water Plan

Prepared by:

CDM Smith
111 Founders Plaza
Suite 1600
East Hartford, CT 06108

Approved:

Michael Jennings, NEIWPCC Quality Assurance Program Manager — Date

for Betsey Wingfield, — 8/3/2016 — Date
Connecticut Department of Energy & Environmental Protection (DEEP)

Lori Mathieu, Connecticut Department of Public Health (DPH) — Date

Kirk Westphal, CDM Smith Project Manager — Date

David Polcari, CDM Smith QA/QC Manager — Date

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Approved:

Michael Jennings, NEIWPCC Quality Assurance Program Manager — Date

Betsey Wingfield,
Connecticut Department of Energy & Environmental Protection (DEEP) — Date

Lori Mathieu, Connecticut Department of Public Health (DPH) — August 5, 2016 — Date

Kirk Westphal, CDM Smith Project Manager — Date

David Polcari, CDM Smith QA/QC Manager — Date

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CDM Smith
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Suite 1600
East Hartford, CT 06108

Approved:

Michael Jennings, NEIWPCC Quality Assurance Program Manager	Date
Betsey Wingfield, Connecticut Department of Energy & Environmental Protection (DEEP)	Date
Lori Mathieu, Connecticut Department of Public Health (DPH)	Date
	**8/8/2016**
Kirk Westphal, CDM Smith Project Manager	Date
David Polcari, CDM Smith QA/QC Manager	Date

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Quality Assurance Project Plan (QAPP) for:
Connecticut State Water Plan

Prepared by:

CDM Smith
111 Founders Plaza
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Approved:

Michael Jennings, NEIWPCC Quality Assurance Program Manager	Date
Betsey Wingfield, Connecticut Department of Energy & Environmental Protection (DEEP)	Date
Lori Mathieu, Connecticut Department of Public Health (DPH)	Date
Kirk Westphal, CDM Smith Project Manager	Date
David Polcari, CDM Smith QA/QC Manager	8/3/16 Date

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Appendices

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1.3 – Distribution List

Signed Copies of this Quality Assurance Project Plan (QAPP) and all subsequent revisions will be sent to the following individuals by e-mail:

NEIWPCC: Michael Jennings, Quality Assurance Program Manager, mjennings@neiwpcc.org

CDM SMITH: Kirk Westphal, Project Manager, westphalks@cdmsmith.com; Sue Morea, Project Director, moreasc@cdmsmith.com; John Boyer, Task Leader for Data and Analysis Activities, boyerjd@cdmsmtih.com; Elaine Sistare, Task Leader for Task Leader for Stakeholder Involvement, sistareEC@cdmsmith.com; and David Polcari, QA/QC Manager, polcaridg@cdmsmith.com.

MILONE AND MACBROOM, INC: David Murphy, davem@miloneandmacbroom.com

1.4 – Project/Task Organization

NEIWPCC:

Michael Jennings, Quality Assurance Program Manager (QAPM): Maintains NEIWPCC Quality Management Plan; designates authorized staff to oversee the review and approval of the QAPP and subsequent revisions in terms of quality assurance aspects.

CDM Smith:

Kirk Westphal, Project Manager (PM): Manages execution of the project, including coordination of quality assurance activities and deliverables.

Sue Morea, Project Director (PD): Provides overall projection direction and Task Leader for Policy Issues.

John Boyer, Task Leader for Analytical Support: Responsible for data collection, analysis, and use. Responsible for QAPP development, maintenance, and distribution of the approved QAPP.

Elaine Sistare, Task Leader for Stakeholders. Coordinates public outreach and stakeholder involvement.

Milone and MacBroom, Inc.:

David Murphy: Will oversee and participate in various aspects of data collection and evaluation, policy assessment, and stakeholder outreach.

Others:

The project is directed by the Connecticut Water Planning Council (WPC), which is comprised of representatives of the four state agencies participating in the State Water Plan development. They are the Department of Energy and Environmental Protection (DEEP), the Department of Public Health (DPH), the Public Utilities Regulatory Authority (PURA), and the Office of Policy and Management (OPM).

Section 2. Project Definition, Objectives, Organization, Approach

2.1 – Problem Definition/Background

The Connecticut Water Planning Council (WPC) is developing a state-wide water plan to provide a framework for water policy and planning to inform and influence future legislation.
This project will develop recommendations for the long-term management of Connecticut's water resources, and other requirements identified in Connecticut Public Act No. 14-163. The State Water Plan is not intended to provide answers or resolution to all of Connecticut's water issues, but rather, it is intended as a framework to recommend policies and management strategies, provide a framework for future decision-making, prioritize key issues, and identify opportunities for improved or more efficient water management in the future. Workshops throughout the planning process will help define reasonable end-goals for each water issue to be addressed, whether the goal is a consensus-based and science-based policy recommendation, or a framework for further information gathering and decision making. This work will build on the water planning work to date by the WPC, its subcommittees, and its Advisory Group, and seek to find areas of consensus and pathways toward progress.

The Plan will be based on the collective will of stakeholders and policy makers, noting areas of common ground and divergence of opinions or needs, future opportunities for regional or sectoral collaboration, as well as hurdles that must be overcome to implement new policies. It will also prioritize issues, both policy and infrastructure, that require immediate attention, or which can be managed adaptively as climate and regulatory conditions evolve. Most importantly, it will provide paths forward; clear, decisive steps toward resolution of conflict and adoption (or not) of new water management policies in Connecticut. In short, the Plan as delivered will include:

- An assessment of future impacts and risks to water supply (consumptive and non-consumptive uses) and quality, including from the effects of climate change, instream flow management, growing demand, potentially developing watersheds, expansion of waters allowed to be public supplies, and aging infrastructure.
- Draft language for proposed water management policies where consensus is achieved among stakeholders.
- Pathways forward for issues that cannot be resolved through consensus in the 1-year Plan development process, which may include additional information needs, decision frameworks, and management structures for overseeing continuing efforts.

CDM Smith will guide the formulation of the State Water Plan for Connecticut for delivery prior to July 1, 2017.

2.2 – Project/Task Description

CDM Smith staff will work with the WPC Steering Committee and WPC Science and Technology Subcommittee to identify and acquire data from federal, state, local government and other sources.

Data collection will be assisted by the spreadsheet of available sources developed by the Science and Technology Subcommittee (made available to CDM Smith), and by meeting minutes from a June 2015 workshop with various committees. This project will not involve collecting new data during the course of the project (for example, collecting new field data), but gathering and organizing existing information to the extent that it is already available. Where data gaps exist, they will be identified so that future data can be collected to help implement and adapt the Plan. While many forms of collected data will be at the local level, it is assumed that CDM Smith will aggregate or regionalize the data for planning purposes and public use or distribution.

Timeline

Execution of the Plan has been divided into two phases, and each phase has work tasks related to four primary categories. The four task categories are repeated for the two phases of work as follows:

PHASE I (Through Nov. 2016)	PHASE II (Through April 2017)
Task 1A: Stakeholder Engagement	Task 2A: Stakeholder Engagement
Task 1B: Policy Assessment	Task 2B: Policy Formulation
Task 1C: Analytical Support	Task 2C: Analytical Support
Task 1D: Documentation	Task 2D: Documentation

The anticipated project (Phase II) end date is April 30, 2017. The primary goals of each phase are as follows:

Phase I Goals:

- Establish definition of the Plan, its objectives, and its processes.
- Assess current conditions and practices.
- Evaluate future conditions.
- Prioritize issues and alternatives for Phase II.

Phase II Goals:

- Develop consensus-based policy recommendations where possible.
- Develop pathways toward resolution of unresolved issues.
- Formulate a decision framework for water issues.
- Define opportunities for regional collaboration.

Task 1A: Stakeholder Engagement

CDM Smith will conduct an internal Project Quality Management (PQM) meeting to determine project goals, critical success factors, and QA/QC procedures for the project (this is part of CDM Smith's internal quality management procedures and a requirement for a project of this scope). Facilitated workshops with WPC Steering Committee and Subcommittees will provide a centralized

discussion forum in which the majority of stakeholders are represented and in which areas of consensus can be sought. CDM Smith will work with its subconsultant, Milone and MacBroom, Inc. (MMI), to coordinate efforts so the WUCC objectives and the State Plan objectives do not result in divergent objectives or recommendations.

Task 1B: Current Policy Assessment

The project team will perform the following:

- Describe the existing management structure at the state, regional, and local levels (including roles and responsibilities of agencies and committees), and identify significant components of the decision-making process.
- Prepare a white paper consolidating and describe current conservation patterns, trends, or plans with a focus on land management and economic development plans.
- Characterize potential water management alternatives with respect to current application in Connecticut, New England, and other states, and identify problems that each alternative could potentially address and Economic Development Trends.
- Identify and discuss perceived conflicts and challenges identified during the preparation of the planning process through collaboration with the WPC Steering Committee. Several white papers will be developed on these topics and will eventually become sections of the State Water Plan.

Task 1C: Technical Condition Assessment

Data collection and inventory will include summarizing the legislation for the Water Plan development and taking inventory of surface water sources, groundwater sources, and infrastructure capacity throughout the state. Data gaps will be identified in this process. This task includes the development of the QAPP.

Task 1D: Documentation

Monthly progress reports will be provided to NEIWPCC, including, but not necessarily limited to, the following; Activities during the month, planned activities in the coming month, issues, resolution of prior issues, schedule assessment, budget summary, and hours billed by project staff for the month and to date. The Phase I Report will be submitted as a partial draft, and will be the foundation for the policy decisions and/or guidelines that will be established in Phase II (Objectives to guide, Analysis to inform, and Priorities to expedite).

Task 2A: Stakeholder Engagement

Stakeholder meetings will continue in the second Phase of the project. Specifically, five facilitated workshops are proposed for Phase II of the project: Water Management Alternatives, Policy Consensus, Paths Forward, Policy Recommendations, and Plan Recommendations. CDM Smith will also facilitate three public meetings in different regions of the state to help disseminate information and answer questions about the State Water Plan.

Task 2B: Policy Guidelines

For water management strategies around which consensus has been achieved, the project team will draft recommended policy guidelines to aid regulatory agencies and legislative assemblies. For strategies that require further analysis, discussion, or data, the project team will develop recommended paths toward consensus, including recommendations for additional studies if necessary, participants in the process, and a series of decision points (or a decision tree) for either advancing the issue or determining its infeasibility. As deemed necessary through the workshops, the team will develop templates or guidelines for local and/or regional development of plans or measures that may be needed to address system-specific impacts. Based on discussions with the WPC Steering Committee, the team will recommend an organizational structure at the state, regional and local levels, incorporating land and water management plans and programs into the framework.

Task 2C: Analytical Support for Alternatives Assessment

Analytical tasks will help inform or facilitate the policy discussions involved in the workshops (2A) and Policy tasks (2B). As such, they will not have individual deliverables, but will be summarized in the relevant sections of the State Water Plan.

Task 2D: Documentation

The Final Draft Report will be the recommended State Water Plan to the WPC Steering Committee, which can be used to report to the Connecticut State Legislature. It will contain all of the white papers and technical memoranda developed in separate tasks, either in main report sections or as Appendices.

Section 3. Sources of Secondary Data

3.1 – Data Sources and Generators

Data used to support this project and inform the State Water Plan will rely mostly on existing data which will be obtained primarily from federal, state and local government agencies, but may also come from academic institutions, non-government organizations and for-profit companies. The Science and Technology Subcommittee has already developed a list of water resources data to support the State Water Plan. The data list, which is included in Appendix A, characterizes the data need, scale, source, format and other attributes. The most common sources of data will include the United States Geological Survey (USGS), DEEP and DPH. While the USGS is considered a generator of data, DEEP and DPH more commonly serve as compilers and repositories of data collected from numerous sources.

Since these datasets will be coming from different sources, and will be at different resolutions and in different datums and formats, special attention will be paid to the integration and harmonization of the datasets. All data sources will be fully referenced in deliverables prepared as part of this project.

3.2 – Hierarchy of Data Sources

Data that have been collected under an approved QAPP or other accepted quality procedure or program and have trustworthy metadata will be given preference to other sources of data. All data selected for inclusion in the final report deliverables will be evaluated and ranked for data quality based on the data source. The quality criteria in ranked order are: collected under a QAPP or a documented Standard Operating Procedure, published in a peer-reviewed scientific journal, published in a technical report, and from an unpublished database. If more than one data source is available from an unpublished database, the data will be evaluated and the highest quality, most complete (in terms of spatial and temporal coverage) data source will be used.

Section 4. Quality of Secondary Data

4.1 – Data Quality Requirements

Data should meet the following quality requirements. It is possible that some datasets will not meet one or more requirements; these data may still be valuable for the project and, if used, any quality concerns will be communicated to the WPC Steering Committee and fully documented in the final report.

- Data or models were generated by a reliable source. Although the identity of the data generator does not guarantee data quality, it provides a simple screening criterion when multiple data sources are available. The following are indicators of data source reliability:
    - Data, models, or models using data generated under a QAPP.
    - Data generator is generally trusted and respected (federal, state, and local agencies, or research institutions; examples include, but are not limited to USGS, NOAA/NWS, DEEP, DHP, University of Connecticut).
    - Data are published in peer-reviewed articles or publications.
- Data have been collected for purposes similar to ours, i.e. analysis of water availability, water withdrawals and discharges, water demands, etc.
- A relevant model has a QAPP or similar plan documenting quality assurance and quality control procedures to ensure data accuracy, precision, representativeness, and comparability.
    - Data or models have been widely used and/or trusted by scientists and professionals in the field.
- Most recent datasets will be prioritized over older datasets, though all relevant data will be considered.
- Completeness
    - Spatial coverage
        - *Dataset provides good coverage of the geographic area of interest and the same sites are included in each sampling effort.*

- Temporal coverage
    - *Enough historical data are available (the farther back in time, the better) to provide historical trend assessment for forecasting.*
    - *Adequate frequency. In general, the more frequent the sampling, the better; however, there is a risk of having too frequent of data (e.g., daily historical water withdrawal data) which would make analysis of trends more cumbersome.*
- Models are continuously updated. This is not strictly required, but highly desirable as the availability of future data would provide for validation of, or for a future update, of deliverables generated by this project.

4.2 – Data Review and Evaluation

Any limitations and gaps in data included in the final deliverables for this project will be fully disclosed within the report, and it will be noted that these data should be used with caution. For example, certain datasets may only cover a limited window in time but still be crucial to complement or provide a perspective for other available data. Even if data are not of the best quality, they may represent the best available knowledge for that particular subject and may not only provide a glimpse into current conditions, but also point to the need for improved data collection efforts to help refine recommendations of future projects.

The quality of the secondary data will be determined according to the decision tree shown in **Figure 1** and based on data quality requirements defined in Section 4.1 of this document. In determining data quality, the source of the dataset will be assessed first, by inspecting a data description (usually metadata) or the dataset itself—whichever is more easily available. If the data description shows that the information was collected using standard procedures and the quality was documented (quality requirements will be assessed by inspecting the QAPP if available, other QA/QC documentation, metadata, and/or other information obtained from data providers), the data will be deemed usable. In cases where completeness is not deemed adequate, the data can be used if necessary but any resulting limitations will be disclosed.

4.3 – Disclaimers

As stated previously, any limitations in data quality or completeness will be fully disclosed within the deliverables the data appears. If a decision is made to use data of unknown quality, this will be indicated in a disclaimer that will be added to the deliverable. An example disclaimer could read, "These data are of unknown quality and presented here for illustrative purposes only. No inferences regarding water quality trends should be made based on these data until their quality can be determined."

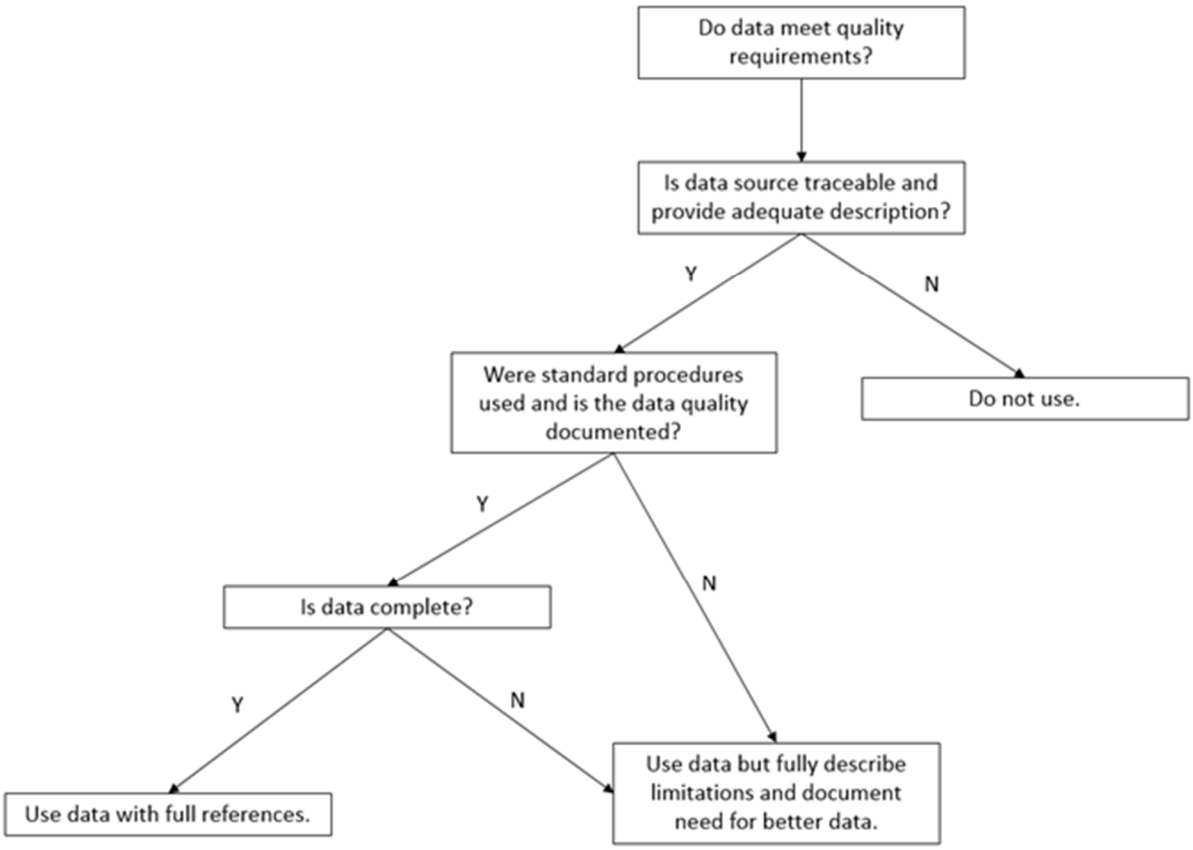


Figure 1. Data Quality Decision Tree

Section 5. Data Reporting, Data Reduction, Data Validation, Data Security and Records Management

5.1 – Documentation of Data Sources and Records

While not all datasets that will be accessed for this project have been identified at this time, a list of possible datasets is provided in Appendix A. Any additional datasets acquired to inform the final deliverables developed for this project will be considered for data quality as described in Section 4.1 and documented in the final State Water Plan if used.

The project team expects to rely almost exclusively on secondary data (exceptions being data that are newly generated through analysis, such as water budget calculations, or simple analysis to evaluate water management alternatives, as described by example in Section 5.3). Secondary data may be combined with other data in a manner as part of the data analysis. For example, water demand and use data may be combined and reported on a watershed level. In these instances, the

underlying data source will still be documented. More detailed information about the data source and interpretation methods will be documented as noted in Section 5.5.

5.2 – Data Validation

The reporting of accurate project data will generally be ensured by carefully conducting and clearly expressing data reduction (if and when needed) and visual inspection of data and model outputs before synthesizing for the final report. To help ensure the reporting of accurate project data, the project team will follow CDM Smith's internal Quality Procedure[1] (QP) 2.2 – Independent Checking. Other actions the project team will take include:

- A copy of every original dataset or model output obtained from each data source will be saved in a separate folder where it will not be edited in the event the integrity of the working datasets is compromised.
- Working data will be stored in spreadsheet format and will include all relevant raw data.
- Data manipulation will be minimized to decrease the chances of inadvertently introducing errors. While we do not anticipate the need for significant manipulation of data, it may be necessary depending on the original format in which those data are obtained. When data reduction or manipulation is needed, it will be calculated starting from the raw dataset whenever possible. All formulas, along with units and conversion factors, will be available in the spreadsheet; in addition, the formulas will be visible in each cell containing the reduced values.
- Prior to inclusion in the final report, raw and/or reduced data will be displayed in graphic form and inspected to detect any anomalous value. Most datasets to be used for synthesis in this report will have been measured in the past and values are expected to fluctuate between "generally accepted values." If apparently anomalous values are detected, any data reduction will be verified. If the seeming anomaly is present in the original dataset, the data generator will be contacted for clarification and/or the issue will be discussed with the appropriate NEIWPCC Technical Representative, members of the CT WPC, or other appropriate parties. Any decision to eliminate "anomalous values" will be documented in the working data spreadsheets which will be kept as part of the project files.
- On rare occasions, a dataset may only be available in hard copy format. In these cases, data will be manually entered into a spreadsheet if necessary. To ensure an error-free copy, summary statistics will be checked if possible. In addition, a few individual values will be cross-checked as well.

The CDM Smith PM or designee will review all acquired data and model outputs. It is possible that members of the WPC also will review some of the acquired data. The CDM Smith PM will have the

[1] *CDM Smith's QPs are considered confidential business information, and are therefore not included as an attachments to the QAPP; however, CDM Smith staff working on the project may access them through the hyperlinks. As needed, the QPs may be reviewed by NEIWPCC and other interested parties (but not distributed).*

authority to temporarily stop work upon finding a significant condition that would adversely affect the quality and usability of the data.

The CDM Smith PM will document, implement, and verify the effectiveness of corrective actions, such as an amendment to the QAPP, and take steps to ensure that everyone on the distribution list is notified.

The CDM Smith PM or designee will provide review and approval of the data before closure of the project. Datasets lacking appropriate metadata will not be used in any analysis or interpretation published in the final deliverables for this report. In-house documentation of assembled datasets will be reviewed to verify references to the use and limitations of the data.

Once the data results are compiled, the CDM Smith PM or designee will review the data quality to determine if the data fall within acceptable limits per user requirements. Applicability of the data will be evaluated on a task-by-task basis when necessary. Limitations of the data will be discussed and documented within the final report for this project. Efforts will be made to identify inconsistencies in the base data or correct errors in the attribute data. If inconsistencies are found in the quality of the base data, an effort will be made to identify and obtain more accurate base data.

NEIWPCC may implement, at its discretion, various audits or reviews of this project to assess conformance and compliance to the quality assurance project plan in accordance with the NEIWPCC *Quality Management Plan*.

5.3 – Data Analysis and Reduction

Data analysis and reduction will be required to develop water budgets, identify trends in water quality and quantity, determine water availability, compare supply and demand, and directly support numerous other portions of the Technical Condition Assessment (Task 1C) and subsequent tasks. Some examples of data reduction may include (but are not limited to):

- Combining and summarizing data at the appropriate hydrologic unit to develop water budgets or evaluate impacts of water management alternatives. This may include the use of simple spreadsheet models.
- Changing data units to allow comparisons across data sources or for consistency in reporting.
- Expressing data as percent, to facilitate comparison.
- Using geoprocessing techniques to combine, analyze, and summarize GIS data.
- Comparing data to benchmarks, permit limits, or historical data.
- Normalizing data on a per capita basis to facilitate projections.

When data analysis and reduction methods are used, the project team will follow CDM Smith's appropriate internal QPs. These may include the following:

- QP 7.2 – Computer Application Based Calculation
- QP 3.7 – Preparation of Computer Assisted Hand Calculations and Paper Calculations

5.4 – Deliverables and Data Security

The deliverables for this project will include memoranda, fact sheets, white papers, meeting summaries, and draft and final versions of the State Water Plan Report. Secondary data collected as part of this project will be compiled, reviewed, analyzed, and summarized in one or more of these project deliverables as deemed appropriate. All data published in the final project deliverables will be cited to its original source.

In preparing deliverables for this project, data that is proposed for inclusion will be reviewed by the CDM Smith Project Manager or Task Leader for Analytical Support to help ensure to the best of our ability that all information and data published in the deliverables will not contain or reveal information the disclosure of which may result in a security risk to a water company. This may include any materials that depict or specifically describe critical water company operating facilities, collection and distribution systems, or sources of supply. Prior to releasing final deliverables, the Project Manager will consult with DPH and other parties to confirm compliance with Section 1-210 Access to public records - Exempt records. As part of the data collection process, Project staff will ask the provider of the data, where appropriate, if they believe that any of the information being shared constitutes a potential security risk and how the data may be used, shared, and published.

5.5 – Records Management

Secondary data collected by the project team used in the final deliverables for this project will be stored by CDM Smith and accompanied with documentation of the data source, date collected, and provider contact information. The project team will follow CDM Smith's internal QP 3.1 – Document Control and Filing, to ensure proper records management.

The data collected and used by the project team will be archived following CDM Smiths record retention policies specified in QP 3.2 – Records Control.

Appendix A – List of Known Datasets and Sources

(Tech Subcommittee spreadsheet)

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
Quantity - Basic Resource Data						
Topographic imagery maps	deterministic models, watersheds, development potential, service opportunities, flooding, storm drainage, Reference map	varies, 2 ft. preferred but 5 ft. ok, 1:24,000	Yes	CLEAR, USGS	GIS, Digital Raster, paper	
Orthoimagery maps	deterministic models, watersheds, development potential, service opportunities, flooding, storm drainage	varies, 3 ft. preferred but 5 ft. ok	Yes	CLEAR, MAGIC, USGS	GIS, Digital orthoquads	
Hydrography	deterministic models	varies	Yes	USGS	GIS	This encompasses all surface water bodies, including lakes, ponds, reservoirs, brooks, streams & rivers
hydrologic boundaries	deterministic models, watershed delineation	varies	Yes	USGS	GIS	
groundwater levels	deterministic models, stream impact - feeder or drainer	varies, seasonal	Yes, Some	DEEP (permit monitoring), USGS	GIS, ONLINE	Data sparse across state
tidal reach	deterministic models, stream class, water quality, suitability for use	varies	Yes	tidal maps, navigation maps	GIS	
Bedrock Geology	deterministic models, development potential, ground water, source potential, contamination transport	varies	Yes	USGS	GIS	some quadrangle maps are not published
Surficial Geology	deterministic models, land use, source potential, contamination transport	varies	Yes	USGS, County soil survey	GIS	
Surficial Aquifer Potential	deterministic models, source potential, aquifer protection	varies	Yes	DEEP, Uconn, local APZ mapping	GIS	
Soil maps	deterministic models, supply, recharge, contamination transport, on-site septic potential	varies	Yes	NRCS	GIS	
Daily Precipitation	deterministic models, quantity available/recharge	varies, daily	Yes	National Weather Service-daily/regional, NOAA	digital database, EXCEL	
evapotranspiration	deterministic models, reduction in supply	varies, seasonal	Yes		digital database	
runoff	deterministic models, water quality, recharge, drainage basins	varies, Temporal	Yes	State and Local drainage system maps, NRCS, CLEAR	digital database, Calculation	based on soils, cover, precip
interstate basin flows	deterministic models	varies	Yes			major rivers
Stream flows	deterministic models, natural flow patterns	seasonal, bio periods	Yes	DEEP, USGS	ONLINE	estimated on stream gage locations

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
stream gauge locations	deterministic models, flow calculations	varies, spatial	Yes	DEEP, USGS	GIS	
stream stats data (locational and flow)	deterministic models, flow calculations	varies, spatial and temporal	Yes	DEEP, USGS	GIS, ONLINE	
streamflow classifications	deterministic models, theoretic demand/need	varies, seasonal, bio periods	Yes, Partial	DEEP	GIS	Classifications in process
NOAA flood maps	at risk supplies			NOAA, FEMA	Digital	
Drought Information				OPM		Drought conditions affect landscape, groundwater, ecology, feeder streams, small water bodies, wetlands, far more often than what is acknowledged by state, towns, utilities as "official" droughts. Marginal and major droughts may become more frequent, more widespread and longer lasting in the future due to climate change but will be harder to identify because they may be punctuated by more frequent, more intense heavy precipitation events.
Quantity - Factors affecting streamflow & water budget						
diversion / registration data	deterministic models, authorized withdrawals	varies, temporal, multiple	Yes	DEEP, permit holders, registrants	Digital spreadsheet	Not all diversions metered (e.g. interbasin raw water transfers), Need to improve format & availablity
size and location of dams	deterministic models, impoundments, releases, run-of-river	varies, spatial	Yes	DEEP	GIS	
location of reservoirs	deterministic models, sources of supply, quality, protection	varies, spatial	Yes	DEEP, DPH	GIS	Security concerns
water service areas	deterministic models, public/community water service areas	varies, spatial	Yes	DPH, Water Utilities	GIS	
diversions less than 50,000 gpd						determined from process of elimination.
return flows						
location of PWS not included in WSP						
locations of non-public supply wells	deterministic models, private water service areas	varies, spatial	Yes	DPH	paper files	location of wells needed at basin level and may not be needed at statewide scale
sewer service areas	deterministic models, public sewer service areas	varies, spatial	Yes	DEEP, OPM	GIS	Data need to be updated?
areas served by septic systems	deterministic models, private /on-site wastewater management	varies, spatial	Yes, Some	Local health districts/depts, DEEP, DPH	Electronic, paper file	located where sewers are not. Finer detail needed in areas where public water and onsite septic is present on a smaller scale. Most not digitized. Local Health Departments have plans for septic systems with flows 5000 gpd and under. DEEP has information on septic systems greater than 5,000 gpd.

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
storm sewer discharge locations / outfalls	deterministic models, drainage, discharge location, point source pollution	varies, spatial	Yes	municipalities, Town and State maps, COG	Some GIS	No comprehensive electronic layer
location of sewage treatment plants / discharge locations	deterministic models, recharge volume, water classification, point source pollution potential	varies, spatial	Yes	DEEP	GIS	
location of LID and groundwater recharge systems	deterministic models	varies	Yes, Some, No	NEMO, DEEP, CLEAR	paper files, online database	Just beginning to collect these data
geothermal wells	deterministic models	varies	Yes, Some	Local Health Departments, DEEP, DCP	paper files, electronic	Will vary by Health Dept
identify and quantify water reuse						
groundcover	deterministic models	varies	Yes, Some	CLEAR, NRCS	?	
Quality						
water quality classification maps	protection areas, land use potential	Spatial	Yes	Uconn, DEEP	GIS	
impaired waters	at risk streams, lakes, ground or surface water contamination	Spatial and Temporal	Yes	DEEP	GIS	
Trophic status of lakes						
known problems areas of water quality / quantity	prioritization opportunities	Temporal	Some	DPH, local health depts, DEEP (Impaired waters list), Utilities	Elect, hard file	Impairments and CCRs
storm sewer maps	as above plus combined sewer overflows	Spatial	Yes	DEEP for combined, Municipalities, COG	Some GIS	No comprehensive electronic layer
storm water discharge locations / outfalls	as above plus combined sewer overflows	Spatial	Yes	DEEP for combined, Municipalities, COG	Some GIS	No comprehensive electronic layer
designated trout streams / special habitat areas	protection areas, land use potential		Yes	DEEP	GIS	
land cover / land use GIS layer	source protection, land use	Spatial	Yes	Local and State Plan of CD, local zoning, CLEAR	GIS	30 m resolution
areas affected by road salt	impact on ground and surface water quality					streamside vegetation and aquatic habitat
Environmental Data						
species of fish in a stream, lake or other water body			yes	DEEP	paper files, some electronic	
macroinvertebrate data			yes	DEEP	paper files, some electronic	
location of headwaters						wildlife action plan (DEEP)
endangered species areas			Yes	CLEAR, DEEP	digital (GIS layer)	

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
anadromous fish areas			Yes	DEEP	GIS	
wild / scenic designation areas	minimum flow	seasonal	Yes	CLEAR, DEEP/State Tourism	digital (GIS layer)	
conservation areas	development restrictions		Yes	CLEAR, DEEP, local plans	digital (GIS layer)	may not be complete
planned conservation areas	development restrictions			State and Local plans		
wildlife management areas	development restrictions		Yes	CLEAR, State and Local plans, DEEP	digital (GIS layer)	
fish passage in streams or lakes						
fisheries assemblages						
study to estimate health of a stream based on other factors (ie. Land use)						TMDLs, pollutant loads based on land use
Understanding CT's Water Demands						
SWUDS data						database available; DEEP has grant proposal in to tweak & populate for CT
current water uses	demands - allocation vs actual; who using for what purposes, seasonal variations	Temporal		DEEP (permitted diversions); DPUC/PURA reports, IWSP		
diversion / registration data	authorized withdrawals, inactive but not abandoned	Temporal	Yes	DEEP, permittees, registrants		Not all diversions metered, e.g., interbasin raw water transfers, may be FOI concerns depending on locational information, degree of aggregation. Need to improve format & usability / need to improve format & usability. Need to improve format & usability
size and location of dams	as above		Yes	DEEP	GIS	Security concerns for water supply
PWS watershed areas	land use, aquifer protection	Spatial	Yes	DEEP, DPH annual reports, water utilities	Digital spatial, GIS	
potential sources of PWS	aquifer potection, land use, future withdrawals/demand		Yes, Some	DPH source data, IWSP, land development (irrigatin needs)	Digital spreadsheet, GIS	Those identified by utilities
PWS water supply plan data			Yes	DPH, water utilities	electronic (pdf), hard copy	Category is too broad, security concerns
aquifer protection areas	as above		Yes	DEEP, water utilities	Digital spatial, GIS	
water service areas	as above		Yes	DPH, Utilities		
locations of public wells	as above		Yes	DPH, water utilities	GIS	APA is specific enough for SWP purposes, security concerns
locations of private wells	as above		Yes	Local Health Depts, DEEP, DCP	paper copies/digital on FTP website (DCP)	mostly paper, DCP FTP digital database difficult to navigate. Some well completion reports may list lot numbers prior to an address being assigned and makes it difficult to pinpoint to an address
interbasin transfers / interconnections	sustainability			DEEP, Water utilties		
impervious surface	quality, runoff volume, detention		Yes	CLEAR	digital (GIS layer)	Effective impervious surface / 30 m resolution

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
location of planned development	demand, stormwater impact		Yes	State and local plans of C&D, OPM, municipalities	GIS	
location of agricultural areas	demand, water/soil quality impact	seasonal	Yes	CLEAR, local land use plans/maps, zoning maps, Plan of C&D, DEEP	digital (GIS layer)	
location of irrigation uses	demand, quality	seasonal	some	local plans, nursery/greenhouse, DEEP registrations, golf web site		when diversion permits or registrations exist
cooling water uses	demand, alternate use opportunity			DEEP		
gravel washing	demand, alternate use opportunity	seasonal		DEEP, local land use plans		
in stream water uses	quality requirement - below potable standard	seasonal				
designated trout streams / special habitat areas	special quality requirements? (temp)	seasonal	Yes	CLEAR, DEEP	digital (GIS layer)	
recreation areas	development restrictions		Yes	State and Local plans, DEEP	GIS	may not be complete
census data	future trends/demands, supply needs		Yes	OPM, US Census, CT.GOV	Digital downloads, ONLINE	
per capita consumption	local, regional, state-wide comparison; cultural shift	seasonal	Yes	Water Utilities, Individual Water Supply Plans, DPH	Hard copy or electronic files (pdf)	Variable by region
alternative water supply uses	to guide policy decision makers, reservation of drinking water supplies		Yes	AWWA, EPA	Electronic, hard file	
factors that will change water use	demand impact		Yes	Alliance for Water Efficiency, AWWA, EPA	Website, Electronic, hard file	
technologies for water conservation	set standards for building codes, demand impact		Yes	Alliance for Water Efficiency, AWWA, EPA	Website, Electronic, hard file	
repair permits for wells / hydrofracting	maintenance/public supply expansion		Some, Yes	DPH, Local Health Departments	electronic, paper files	Will vary by Health Dept
end users of water				Some customer classification data from water utilties		
operation of dams						core of engineers, NRCS, FERC, DEEP, Water suppliers
exclusive service areas				WUCCs		
leakage of infrastructure						Water supply plans for PWS supplying >1000 people. Private Water Companies regulated by PURA
groundwater recharge areas						locations where there are wells and sewers bringing water out of basin
groundwater availability						
groundwater quantity						

Appendix A - Data Needs and Sources to Support the Connecticut State Water Plan

Prepared by the Science and Technical Subcommittee

Type of Data Needed	Why are These Data Needed?	Spatial and Temporal Scale	Do Data Exist?	Source	Data Format	Comments
storm water discharge locations / outfalls						River Watch - Earthplace Westport Nature Center. Richard Harris main contact.
salt water intrusion						
groundwater						
private wells				local health departments		
Recreation						
recreation areas: canoe/kayak access locations	paddle sports are acutely affected by water levels, flow, quality, access, aethetics	statewide scope, individual water-body scale.	mostly complete on rivers alliance website	Rivers Alliance of CT: http://www.ctwatertrails.org/db/water20150727.csv	spreadsheet with links, lat/long	Needs more individual town research
recreation areas: boat launch locations and associated levels, flow, quality, conditions , economic impact.	boating is affected by water levels, flow, quality, access, aethetics		CT DEEP GIS layer only has state launches, not town or private	DEEP		
recreation areas locations: Connecticut Coastal Access Guide	these resources are affected by water quality	LIS coastal	has paddle access points, boat launches, picnic areas, views, hikes for LIS only	UCONN, DEEP		
recreation areas locations: public, private beaches and associated levels, flow, quality, conditions , economic impact.	swimming is affected by water quality	statewide scope, individual water-body scale	unknown	health departments?		
recreation areas: marina locations and associated levels, flow, quality, conditions, , economic impact.	boating is affected by water quality, water levels					
recreation areas: data on aesthetic, recreational, property value of water resources	these could be affected by low flows, building, pollution, other impacts of water use.	statewide scope, individual water-body scale.				

APPENDIX D

Community Water Systems, Municipality and Other Water System Tables

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage
Aquarion Water Co. – Mystic System	Stonington / Groton	A, E	A	X	X	X
Aquarion Water Company – Brookfield System	Brookfield	A	U	X	X	X
Aquarion Water Company – Chimney Heights	Bethel	A	U	X	X	X
Aquarion Water Company – East Derby System[1]	Derby	U	U	U	X	X
Aquarion Water Company – Greenwich System	Greenwich	U	A, E	X	X	X
Aquarion Water Company – Litchfield System	Litchfield, Torrington, Goshen	A, E	U	X	U	X
Aquarion Water Company – Main System	Bridgeport, Stratford, Shelton, Trumbull, Monroe, Easton, Redding, Fairfield, Westport, Weston, Wilton	A, E, I	A, I	X	X	X
Aquarion Water Company – New Canaan System	New Canaan	E, I	U	X	X	X
Aquarion Water Company – New Milford System	New Milford	A, E, I	U	X	X	X
Aquarion Water Company – Newtown System	Newtown	A	U	X	X	X
Aquarion Water Company – Norfolk System	Norfolk	U	A	X	U	X
Aquarion Water Company – Noroton System	Darien	A	U	X	X	X
Aquarion Water Company – North Canaan System	North Canaan	A, I	E	X	U	X

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage
Aquarion Water Company – Ridgefield System	Ridgefield	A, E, I	U	X	X	X
Aquarion Water Company – Salisbury System	Salisbury	A	A, I	X	X	X
Aquarion Water Company – Simsbury System	Simsbury, Granby, East Granby	A	I	X	X	X
Aquarion Water Company – Stamford System	Stamford	E	A	X	X	X
Aquarion Water Company – Valley System	Naugatuck, Beacon Falls, Oxford	A, E, I	A, I	X	X	X
Aquarion Water Company – Western Brookfield	Brookfield	A, E	U	X	X	X
Aquarion Water Company – Woodbury System	Woodbury	A, E	U	X	U	X
Avon Water Company	Avon, Simsbury	A, E, I	U	X	X	X
Berlin Water Control Commission	Berlin	A, I	U	X	X	X
Bethel Water Department	Bethel	A	A	X	X	X
Bristol Water Department	Bristol	A, E, I	A, I	X	X	X
Candlewood Shores Tax District	Brookfield	A, I	U	X	U	X
Colchester Water & Sewer Commission	Colchester	A, E	U	X	X	X
Connecticut Correctional Institute	Enfield / Somers	A, E, I	U	X	X	X
Connecticut Valley Hospital	Middletown	U	A, I	X	U	X
Cromwell Fire District Water Department	Cromwell	A, E, I	U	X	X	X
CWC – Central System	Naugatuck, Prospect, Middlebury, Waterbury	A, I	A	X	X	X

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage
CWC – Chester System	Chester, Deep River, Essex	A	A, I	X	X	X
CWC – Collinsville Sys	Canton	U	U*	U	X	X
CWC – Crystal Plainfield	Plainfield	A, E	U	X	U	X
CWC – Crystal Thompson	Thompson	A, E	U	X	X	X
CWC – Crystal Water Company	Killingly / Brooklyn	A, E	I	X	X	X
CWC – Gallup Water Service, Inc.	Plainfield	A, E	U	X	X	X
CWC – Guilford System	Guilford, Madison,	A, E, I	A	X	X	X
CWC – Guilford System	Old Saybrook, Westbrook, Clinton	A, E, I	A	X	X	X
CWC – Hebron Center	Hebron	A	U	X	X	X
CWC – Legend Hill Condominium Association	Madison	A	U	X	U	X
CWC – Point O' Woods	Old Lyme	A, I	U	X	X	X
CWC – Sound View	Old Lyme	A, I	U	X	X	X
CWC – Stafford System	Stafford	I	A	X	X	X
CWC – Terryville System	Plymouth	A	I	X	X	X
CWC – Thomaston System	Thomaston, Plymouth	A, E, I	I	X	X	X
CWC – Unionville System	Farmington, Avon	A, I	U	X	X	X
CWC – Western System	East Windsor, Suffield, Enfield, Somers, East Granby, Windsor Locks, South Windsor, Ellington, Vernon, Tolland	A, E, I	A	X	X	X
Danbury Water Department	Danbury	E, I	A, E	X	X	X
East Lyme Water & Sewer	East Lyme	A, E	A*	X	X	X
First Taxing District of the City of Norwalk Water Department	Norwalk, New Canaan, Wilton, Westport	A, I	A	X	X	X
Groton Long Point Association[1]	Groton	U	U	U	U	U
Groton Utilities	Groton	A, E	A	X	X	X
Hazardville Water Company	Enfield, Somers	A, E, I	U	X	X	X
Heritage Village Water Company	Southbury, Oxford, Middlebury	A, I	U	X	X	X
Jewett City Water Company	Griswold / Lisbon	A	A	X	U	X
Kensington Fire District[1]	Berlin	I	U	U	X	X
Ledyard WPCA – Gales Ferry System	Ledyard	I	U	U	X	X

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage
Ledyard WPCA – Ledyard Center System[1]	Ledyard	I	U	U	U	X
Manchester Water Department	Manchester, Glastonbury	A, E, I	A	X	X	X
Mashantucket Pequot Tribal Nation	Mashantucket	A, E	U	X	X	X
Meriden Water Division	Meriden	A, I	A	X	X	X
Metropolitan District Commission	East Granby, Windsor, Rocky Hill, Bloomfield, West Hartford, Hartford, East Hartford, South Windsor, Farmington, Newington, Wethersfield, Glastonbury	U	A, E, I	X	X	X
Middletown Water Department	Middletown	A	A, E	X	X	X
Mohegan Tribal Utility Authority[1]	Mohegan	U	U	U	U	X
Montville Water Supply (WPCA)[1]	Montville	U	U	U	X	X
New Britain Water Department	New Britain, Farmington	E, I	A	X	X	X
New Hartford Water Department	New Hartford	A	I	X	X	X
New London Department of Utilities	New London	U	A, E	X	X	X
Noank Fire District[1]	Groton	U	U	U	U	X
Norwich Public Utilities	Norwich / Bozrah / Franklin / Preston / Lisbon	E	A, I	X	X	X
Portland Water Department	Portland	A	I	X	X	X
Putnam WPCA	Putnam / Woodstock	A	A	X	U	X
Salmon Brook District Water Department	Granby	A, E	U	U	U	X
SCWA – Mohegan Division	Montville	A	U	X	U	X
SCWA – Montville Division	Montville	A	U	X	U	X
SCWA – North Stonington Div.	North Stonington	A	U	X	U	X
SCWA – Tower-Ferry Division	Ledyard	A	U	X	X	X
Second Taxing District City Of Norwalk	Norwalk, Wilton	U	A	X	X	X
South Central Connecticut Regional Water Authority	Ansonia, Cheshire, Derby, Seymour	A, E, I	A, I	X	X	X

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage
South Central Connecticut Regional Water Authority	Milford, Orange, West Haven, Woodbridge, New Haven, Hamden, Bethany, East Haven, North Haven, Branford, North Branford	A, E, I	A, I	X	X	X
Southbury Training School	Southbury	A, E	U	X	X	X
Southington Water Department	Southington	A, I	A	X	X	X
Sprague Water & Sewer Commission	Sprague	A	E	X	U	X
Tariffville Fire District Water Department	Simsbury	A, E	U	X	U	X
Tolland Water Department	Tolland	A	U	X	U	X
Torrington Water Company	Torrington, New Hartford, Harwinton, Burlington	I	A, I	X	X	X
Town of Newtown – Fairfield Hills	Newtown	A, I	U	X	X	X
University of Connecticut - Main Campus	Mansfield	A, E, I	U	X	X	X
Valley Water Systems, Inc.	Plainville	A, I	I	X	X	X
Wallingford Water Department	Wallingford	A	A	X	X	X
Waterbury Water Department	Waterbury, Thomaston	U	A, I	X	X	X
Waterford Utilities Commission[1]	Waterford	U	U	U	X	X
Watertown Fire District[1]	Watertown	A, I	I	X	X	X
Watertown Water & Sewer Authority	Watertown	U	U	U	X	X
Westerly Water Department	Stonington	A	U	X	X	X
Windham Water Works	Windham / Mansfield	U	A	X	X	X
Windham Water Works	Windham / Mansfield	U	A	X	X	X
Winsted Water Works	Winchester	U	A	X	X	X
Wolcott Water Department[1]	Wolcott	U	U	X	X	X
Worthington Fire District[1]	Berlin	U	U	U	U	U

A = Active, E = Emergency, I = Inactive; U = Unavailable; X = Available A, E, and I are only used for supplies.

Eastern WUCC Notes

Table 2-5 Major Facilities of Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Groundwater Supplies	Surface Water Supplies	Treatment	Distribution Pumping	Storage

*East Lyme stores groundwater in New London's Lake Konomoc during the winter to meet elevated summer demands (water banking project).

1. Water purchased from another utility via interconnection.

Central WUCC Notes

*CWC – Collinsville System obtains water from an interconnection with MDC's Collinsville Water Treatment Plant.

1. Water purchased from another utility via interconnection.

Western WUCC Notes

N/A

Table 2-6 System Demand, Available Yield, and Margin of Safety for Water Systems Serving > 1,000 People

Water System	Reference Year1 and (Data Source)	Average Day Demand (mgd)	Average Day Available Water2 (mgd)	Average Day Margin of Safety	Maximum Month Average Day Demand (mgd)	Maximum Month Average Day Available Water2 (mgd)	Maximum Month Average Day Margin of Safety	Peak Day Demand (mgd)	Peak Day Available Water2 (mgd)	Peak Day Margin of Safety	Unaccounted-For Water Percentage	Per-Capita Residential Demand (gpcd)
Aquarion Water Company – Brookfield	2015 (PC), 2015 (PAR), 2012 (WSP)	0.320	0.544	1.70	0.393	0.544	1.39	0.519	0.687	1.32	43%	51
Aquarion Water Company – Chimney Heights	2015 (PC), 2015 (PAR), 2015 (WSP)	0.192	0.402	2.09	0.229	0.402	1.76	0.315	0.456	1.45	20%	62
Aquarion Water Company – East Derby	2015 (PC), 2015 (PAR), 2015 (WSP)	0.143	0.260	1.82	0.169	0.260	1.54	0.237	0.350	1.48	0%	NR
Aquarion Water Company – Litchfield	2015 (PC), 2015 (PAR), 2015 (WSP)	0.271	0.566	2.09	0.327	0.566	1.73	0.426	0.621	1.46	13%	44
Aquarion Water Company – Main System[3]	2015 (PC), 2015 (PAR), 2005 (WSP)	43.244	71.530	1.65	57.452	88.320	1.54	66.090	102.610	1.55	10%	73
Aquarion Water Company – Mystic System	2015 (PC), 2015 (PAR), 2005 WSP	1.339	2.100	1.57	1.788	2.530	1.41	2.141	3.100	1.45	18%	55
Aquarion Water Company – New Milford	2015 (PC), 2015 (PAR), 2015 (WSP)	0.999	2.895	2.90	1.088	2.895	2.66	2.056	3.218	1.57	10%	47
Aquarion Water Company – Newtown	2015 (PC), 2015 (PAR), 2015 (WSP)	0.504	1.124	2.23	0.617	1.124	1.82	0.732	1.498	2.05	9%	48
Aquarion Water Company – Norfolk	2015 (PC), 2015 (PAR), 2005 (WSP)	0.090	0.730	8.11	0.142	0.767	5.40	0.216	0.767	3.55	25%	63
Aquarion Water Company – North Canaan	2015 (PC), 2015 (PAR), 2005 (WSP)	0.229	0.610	2.66	0.252	0.610	2.42	0.356	0.706	1.99	13%	56
Aquarion Water Company – Ridgefield	2015 (PC), 2015 (PAR), 2015 (WSP)	0.906	1.782	1.97	1.179	1.782	1.51	1.430	1.944	1.36	12%	74
Aquarion Water Company – Salisbury	2015 (PC), 2015 (PAR), 2005 (WSP)	0.315	1.057	3.36	0.436	1.564	3.59	0.519	1.564	3.01	22%	86
Aquarion Water Company – Simsbury System	2015 (PC), 2005 (WSP)	1.990	4.910	2.47	2.815	4.910	1.74	3.562	6.240	1.75	23%	93
Aquarion Water Company - Southwest Fairfield County Region (Greenwich, Stamford, Noroton,	2015 (PC), 2015 (PAR), 2005 (WSP)	34.170	38.439	1.12	46.610	54.239	1.16	51.320	66.519	1.30	NR	81
Aquarion Water Company – Valley	2015 (PC), 2015 (PAR), 2005 (WSP)	1.186	4.890	4.12	1.410	4.890	3.47	2.003	5.390	2.69	3%	71
Aquarion Water Company – Western Brookfield System	2015 (PC), 2015 (PAR), 2012 (WSP)	0.050	0.093	1.86	0.054	0.093	1.72	0.069	0.112	1.62	11%	55
Aquarion Water Company – Woodbury	2015 (PC), 2015 (PAR), 2015 (WSP)	0.138	0.243	1.76	0.158	0.243	1.53	0.179	0.324	1.81	17%	53

Table 2-6 System Demand, Available Yield, and Margin of Safety for Water Systems Serving > 1,000 People

Water System	Reference Year1 and (Data Source)	Average Day Demand (mgd)	Average Day Available Water2 (mgd)	Average Day Margin of Safety	Maximum Month Average Day Demand (mgd)	Maximum Month Average Day Available Water2 (mgd)	Maximum Month Average Day Margin of Safety	Peak Day Demand (mgd)	Peak Day Available Water2 (mgd)	Peak Day Margin of Safety	Unaccounted-For Water Percentage	Per-Capita Residential Demand (gpcd)
Avon Water Company[3]	2015 (PAR), 2011 (WSP)	1.648	4.777	2.90	2.583	4.777	1.85	3.370	6.388	1.90	3%	82
Berlin Water Control Commission[3]	2011 (WSP)	1.775	2.756	1.55	2.475	2.756	1.11	2.663	3.000	1.13	6%	58
Bethel Water Department	2011-2015 Average (PC)	0.936	1.360	1.45	1.109	1.360	1.23	1.294	1.660	1.28	NR	60
Bristol Water Department	2012 (PAR)	5.232	7.420	1.42	6.726	7.420	1.10	8.840	9.893	1.12	1%	68
Candlewood Shores Tax District	2014 (PAR)	0.057	0.165	2.88	0.070	0.165	2.36	0.125	0.220	1.77	1%	NR
Colchester Water & Sewer Commission	2010 (WSP)	0.337	0.746	2.21	0.374	0.746	1.99	0.493	0.995	2.02	1%	45
Connecticut Correctional Institute	2000 (WSP)	0.740	0.996	1.35	0.884	0.996	1.13	0.950	1.328	1.40	35%	71
Connecticut Valley Hospital	2006 (WSP)	0.301	0.700	2.33	0.320	0.700	2.19	0.560	0.700	1.25	30%	62
Cromwell Fire District Water Department[3]	2015 (PC), 2012 (PAR), 2004 (WSP)	1.750	5.620	3.21	2.500	7.490	3.00	3.500	7.490	2.14	12%	74
CWC – Central System	2015 (PC), 2009 (WSP)	2.760	4.590	1.66	3.260	5.050	1.55	4.144	7.210	1.74	24%	59
CWC – Chester System	2015 (PC), 2009 (WSP)	0.581	1.340	2.31	0.769	1.340	1.74	0.926	1.690	1.83	20%	60
CWC – Collinsville Sys	2015 (PC), 2008 (WSP)	0.439	1.300	2.96	0.677	1.300	1.92	0.822	1.650	2.01	1%	70
CWC – Crystal Plainfield	2015 (PC), 2007 (WSP)	0.164	0.740	4.51	0.182	0.740	4.07	0.278	0.987	3.55	23%	61
CWC – Crystal Thompson[3]	2015 (PC), 2007 (WSP)	0.127	0.216	1.70	0.143	0.216	1.51	0.227	0.288	1.27	11%	68
CWC – Crystal Water Company[3]	2015 (PC), 2007 (WSP)	1.251	2.513	2.01	1.537	2.513	1.64	2.217	3.350	1.51	12%	73
CWC – Gallup Water	2015 (PC), 2007 (WSP)	0.421	0.862	2.05	0.461	0.862	1.87	0.591	0.862	1.46	32%	51
CWC – Guilford System	2015 (PC), 2009 (WSP)	3.865	7.790	2.02	5.683	7.790	1.37	7.007	9.920	1.42	21%	55

Table 2-6 System Demand, Available Yield, and Margin of Safety for Water Systems Serving > 1,000 People

Water System	Reference Year1 and (Data Source)	Average Day Demand (mgd)	Average Day Available Water2 (mgd)	Average Day Margin of Safety	Maximum Month Average Day Demand (mgd)	Maximum Month Average Day Available Water2 (mgd)	Maximum Month Average Day Margin of Safety	Peak Day Demand (mgd)	Peak Day Available Water2 (mgd)	Peak Day Margin of Safety	Unaccounted-For Water Percentage	Per-Capita Residential Demand (gpcd)
CWC – Hebron Center	2015 (PC)	0.030	0.072	2.41	0.043	0.072	1.67	0.080	0.096	1.21	8%	NR
CWC – Legend Hill Condominium Association	2015 (PC)	0.014	0.086	6.14	0.016	0.086	5.26	0.028	0.086	3.07	9%	NR
CWC – Point O' Woods	2015 (PC), 2009 (WSP)	0.047	0.117	2.48	0.090	0.117	1.29	0.123	0.154	1.25	36%	39
CWC – Sound View	2015 (PC), 2009 (WSP)	0.059	0.150	2.55	0.144	0.150	1.05	0.201	0.201	1.00	NR	25
CWC – Stafford System	2015 (PC), 2005 (WSP)	0.535	0.700	1.31	0.601	0.700	1.16	0.723	1.000	1.38	4%	77

Table 2-7 Summary of System Reliability Characteristics for Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Back-up/Emergency Supply	Inter-connections	Emergency Power Availability
Aquarion Water Co. – Mystic System	Stonington / Groton	M, E	Y	Y
Aquarion Water Company – Chimney Heights System	Bethel	N	Y	Y
Aquarion Water Company – East Derby System	Derby	N	Y	Y
Aquarion Water Company – Greenwich System	Greenwich	M, E	Y	Y
Aquarion Water Company – Litchfield System	Litchfield, Torrington, Goshen	M, E	Y	Y
Aquarion Water Company – Main System	Bridgeport, Stratford, Shelton, Trumbull, Monroe, Easton, Redding, Fairfield, Westport, Weston, Wilton	M, E	Y	Y
Aquarion Water Company – New Canaan System	New Canaan	E	Y	Y
Aquarion Water Company – New Milford System	New Milford	M, E	Y	Y
Aquarion Water Company – Newtown System	Newtown	M	Y	Y
Aquarion Water Company – Norfolk System	Norfolk	N	N	Y
Aquarion Water Company – Noroton System	Darien	M	Y	Y
Aquarion Water Company – North Canaan System	North Canaan	M, E	N	Y
Aquarion Water Company – Ridgefield System	Ridgefield	M, E	Y	Y
Aquarion Water Company – Salisbury System	Salisbury	M	N	Y
Aquarion Water Company – Simsbury System	Simsbury, Granby, East Granby	M	N	Y
Aquarion Water Company – Stamford System	Stamford	M	Y	Y
Aquarion Water Company – Valley System	Naugatuck, Beacon Falls, Oxford	M, E	Y	Y
Aquarion Water Company – Western Brookfield System	Brookfield	M, E	N	Y
Aquarion Water Company – Woodbury System	Woodbury	M, E	N	Y
Avon Water Company	Avon, Simsbury	M, E	Y	Y
Berlin Water Control Commission	Berlin	M	Y	Y
Bethel Water Department	Bethel	M, E	Y	Y
Bristol Water Department	Bristol	M, E	Y	Y

Table 2-7 Summary of System Reliability Characteristics for Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Back-up/Emergency Supply	Inter-connections	Emergency Power Availability
Candlewood Shores Tax District	Brookfield	M, E	N	Y
Colchester Water & Sewer Commission	Colchester	M, E	N	Y
Connecticut Correctional Institute	Enfield / Somers	M, E	N	Y
Connecticut Valley Hospital	Middletown	M	N	Y
Cromwell Fire District Water Department	Cromwell	M, E	Y	Y
CWC – Central System	Naugatuck, Prospect, Middlebury, Waterbury	M, E	Y	Y
CWC – Chester System	Chester, Deep River, Essex	M	N	Y
CWC – Collinsville Sys	Canton	N	Y	Y
CWC – Crystal Plainfield	Plainfield	M, E	N	Y
CWC – Crystal Thompson	Thompson	M, E	N	Y
CWC – Crystal Water Company	Killingly / Brooklyn	M, E	Y	Y
CWC – Gallup Water Service, Inc.	Plainfield	M, E	N	Y
CWC – Guilford System	Guilford, Madison, Old Saybrook, Westbrook, Clinton	M, E	Y	Y
CWC – Hebron Center	Hebron	M	N	Y
CWC – Legend Hill Condominium Association	Madison	M	N	Y
CWC – Point O' Woods	Old Lyme	M, E	N	Y
CWC – Sound View	Old Lyme	M, E	N	Y
CWC – Stafford System	Stafford	N	N	Y
CWC – Terryville System	Plymouth	M, E	Y	Y
CWC – Thomaston System	Thomaston, Plymouth	M, E	Y	Y
CWC – Unionville System	Farmington, Avon	M, E	Y	Y
CWC – Western System	East Windsor, Suffield, Enfield, Somers, East Granby, Windsor Locks, South Windsor, Ellington, Vernon, Tolland	M, E	Y	Y
Danbury Water Department	Danbury	M, E	N	Y
East Lyme Water & Sewer	East Lyme	M, E	Y	Y
First Taxing District of the City of Norwalk Water Department	Norwalk, New Canaan, Wilton, Westport	M, E	Y	Y
Groton Long Point Association	Groton	N	Y	Y*
Groton Utilities	Groton	M, E	Y	Y
Hazardville Water Company	Enfield, Somers	M, E	Y	Y
Heritage Village Water Company	Southbury, Oxford, Middlebury	M	Y	Y
Jewett City Water Company	Griswold / Lisbon	M	N	Y
Kensington Fire District	Berlin	N	Y	Y
Ledyard WPCA – Gales Ferry System	Ledyard	N	Y	Y*
Ledyard WPCA – Ledyard Center System	Ledyard	N	Y	Y*
Manchester Water Department	Manchester, Glastonbury	M, E	Y	Y
Mashantucket Pequot Tribal Nation	Mashantucket	M, E	Y	Y
Meriden Water Division	Meriden	M, E	Y	Y

Table 2-7 Summary of System Reliability Characteristics for Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Back-up/Emergency Supply	Inter-connections	Emergency Power Availability
Metropolitan District Commission	East Granby, Windsor, Rocky Hill, Bloomfield, West Hartford, Hartford, East Hartford, South Windsor, Farmington, Newington, Wethersfield, Glastonbury	M, E	Y	Y
Middletown Water Department	Middletown	M, E	N	Y
Mohegan Tribal Utility Authority	Mohegan	M	Y	Y
Montville Water Supply (WPCA)	Montville	N	Y	Y
New Britain Water Department	New Britain, Farmington	M, E	Y	Y
New Hartford Water Department	New Hartford	M, E	N	Y
New London Department of Utilities	New London	M, E	Y	Y
Noank Fire District	Groton	N	Y	Y*
Norwich Public Utilities	Norwich / Bozrah / Franklin / Preston / Lisbon	M, E	Y	Y
Portland Water Department	Portland	E	Y	Y
Putnam WPCA	Putnam / Woodstock	M	Y	Y
Salmon Brook District Water Department	Granby	M	N	Y
SCWA – Mohegan Division	Montville	M	N	Y
SCWA – Montville Division	Montville	M	N	Y
SCWA – North Stonington Div.	North Stonington	M	N	Y
SCWA – Tower-Ferry Division	Ledyard	M	N	Y
Second Taxing District City Of Norwalk	Norwalk, Wilton	M	Y	Y
South Central Connecticut Regional Water Authority	Cheshire, Wolcott, Prospect, Ansonia, Derby, Seymour	M, E	Y	Y
South Central Connecticut Regional Water Authority	Milford, Orange, West Haven, Woodbridge, New Haven, Hamden, Bethany, East Haven, North Haven, Branford, North Branford	M, E	Y	Y
Southbury Training School	Southbury	M, E	N	Y
Southington Water Department	Southington	M, E	N	Y
Sprague Water & Sewer Commission	Sprague	M, E	N	Y
Tariffville Fire District Water Department	Simsbury	E	N	Y
Tolland Water Department	Tolland	M	Y	Y
Torrington Water Company	Torrington, New Hartford, Harwinton, Burlington	M, E	Y	Y
Town of Newtown – Fairfield Hills	Newtown	M, E	Y	N
University Of Connecticut - Main Campus	Mansfield	M, E	N	Y
Valley Water Systems, Inc.	Plainville	M, E	Y	Y
Wallingford Water Department	Wallingford	M	Y	Y
Waterbury Water Department	Waterbury, Thomaston	M	Y	Y

Table 2-7 Summary of System Reliability Characteristics for Community Water Systems Serving >1,000 People

Community Water System	Primary Location Served	Back-up/Emergency Supply	Inter-connections	Emergency Power Availability
Waterford Utilities Commission	Waterford	N	Y	Y
Watertown Fire District	Watertown	M, E	Y	Y
Watertown Water & Sewer Authority	Watertown	N	Y	Y
Westerly Water Department	Stonington	M, E	N	Y
Windham Water Works	Windham / Mansfield	N	N	Y
Windham Water Works	Windham, Mansfield	N	N	Y
Winsted Water Works	Winchester	M	N	Y
Wolcott Water Department	Wolcott	N	Y	Y
Worthington Fire District	Berlin	N	Y	Y*

M: Multiple sources of supply; E: Emergency or Backup source of supply; N: None; Y: Yes.

* Emergency power capabilities provided by source CWS.

Table 2-8 List of Active Interconnections

Supplier	Receiver	Town	Average Day Transfer (mgd)	Year
Aqua Vista Association, Inc. - Upper System	Aqua Vista Association, Inc. - Lower System	Danbury	0	2013
Aquarion - Brookfield System	Aquarion - Brookwood System	Brookfield	0	2012
Aquarion - Greenwich System	Suez Water Westchester	Greenwich*	5.1	2005
Aquarion - Greenwich System	Aquarion – Stamford System	Greenwich*	0.18	2005
Aquarion - Main System	Aquarion – Combined Southwestern Fairfield County system (Greenwich, New Canaan, Noroton, and Stamford systems) & Ridgefield System	New Canaan, Darien, Stamford, Wilton, Ridgefield*	3.8	2005
Aquarion - Main System	South Norwalk Electric & Water	Wilton	0	2005
Aquarion - Meadowbrook System	Aquarion - Pleasant View System	New Milford	0	2014
Aquarion - New Milford System	Aquarion – Brookfield System	New Milford	0.003	2013
Aquarion - Newtown System	Aquarion - Chimney Heights	Bethel	0	2014
Aquarion - Stamford System	Aquarion - New Canaan System	New Canaan	0	2005
Aquarion - Stamford System	Aquarion - Greenwich System & Aquarion – Noroton System	Greenwich*	3.25	2005
Aquarion Water Company - Mystic	Classee Water System-Latimer Point	Stonington	0.003	2013
Aquarion Water Company - Mystic	CWC – Masons Island	Stonington	0.056	2013
Avon Water Company	CWC Collinsville System	Avon	0.025	2011
Berlin Water Control Commission	Kensington Fire District	Berlin*	0.649	2011
Berlin Water Control Commission	Worthington Fire District	Berlin*	0.401	2011
Countryside Apartments	Aquarion - Clearview System	Wolcott	0.008	2014
Cromwell Fire District Water Department	Berlin Water Control Commission	Cromwell	0.308	2011
CWC – Central System	Flow into Middlebury	Middlebury	0.006	2009
CWC – Central System	Heritage Village Water Company	Middlebury	0	2015
CWC – Chester System	Mount Saint John School	Deep River	0.000**	2014
CWC – Thomaston System	CWC – Terryville System	Plymouth	0	2012
CWC – Western System	Tolland Water Department	Tolland	0.05	2016
CWC – Western System	Tolland Water Department – Torry Road	Tolland	0.013	2012
CWC – Western System	Town of Somers – Rye Hill System via Hazardville Water Company	Enfield	0.021	2005
CWC Crystal Water Company	Putnam WPCA	Putnam	0.071	2011
CWC-Guilford System	SCCRWA	Guilford	0	2008
Danbury Water Department	Aquarion - McKeon System	Ridgefield	0.005	2014
Danbury Water Department	Aquarion - Barnum System	Ridgefield	0.011	2013
Danbury Water Department	Aquarion - Berkshire Corporate Park	Bethel*	0.043	2014

Table 2-10 List of Active Interconnections

Supplier	Receiver	Town	Average Day Transfer (mgd)	Year
Danbury Water Department	Aquarion - Hollandale Estates System	Danbury	0.009	2014
Danbury Water Department	Aquarion - Ken Oaks System	Danbury	0.026	2014
Danbury Water Department	Aquarion - Rolling Ridge System	Danbury	0.007	2014
Danbury Water Department	Bethel Water Dept. (The Summit)	Bethel	0.001	2015
Danbury Water Department	Cornell Hills Association	Danbury	0.008	2013
Evergreen Trailer Park – System #2	Evergreen Trailer Park – System #1	Clinton	0	2015
Groton Utilities	Aquarion Water Company - Mystic	Groton	0.100**	-
Groton Utilities	Groton Long Point Association	Groton	0.12	2015
Groton Utilities	Ledyard WPCA, Gales Ferry System	Groton	0.14	2015
Groton Utilities	Ledyard WPCA – Ledyard Center	Ledyard	0.144	2015
Groton Utilities	Montville Water Supply	Ledyard	0.472	2015
Groton Utilities	Noank Fire District	Groton	0.2	2015
Heritage Village Water Company	Aquarion - Oxford Town Center	Oxford	0	2015
Kensington Fire District	Berlin Water Control Commission	Berlin*	0.009	2011
Manchester Water Department	CWC – Western System	South Windsor	0.002	2006
Manchester Water Department	CWC – Reservoir Heights	Manchester	0.005	2014
Mashantucket Pequot Tribal Nation	Preston Plains Water Company	Preston	0	2013
Metropolitan District Commission	Portland Water Department	Portland	0.417	2007
Metropolitan District Commission	Berlin Water Control Commission	Newington	0	2007
Metropolitan District Commission	CWC – Collinsville System	Canton	0.547	2007
Metropolitan District Commission	CWC – Western System	South Windsor	0	2007
Metropolitan District Commission	CWC – Western System	Windsor Locks	0.015	2007
Metropolitan District Commission	CWC – Western System	Windsor	0	2007
Metropolitan District Commission	CWC – Unionville System	Farmington	0.77	2007
Metropolitan District Commission	CWC – Chimney Hill System	Farmington	0.022	2013
Metropolitan District Commission	New Britain Water Department	Burlington	0	2007
Metropolitan District Commission	New Britain Water Department	Farmington	0	2007
Montville Water Supply	SCWA – Hillcrest Division	Montville	0.002	2014
Montville Water Supply (from Groton Utilities)	Mohegan Tribal Utility Authority	Montville	0.193	2015
New Britain Water Department	Bristol Water Department	Bristol, Plainville	0.244	2008
New Britain Water Department	Bristol Water Department	Bristol	0.245	2008
New Britain Water Department	Berlin Water Control Commission	Berlin	0.917	2011
New Britain Water Department	Kensington Fire District	New Britain*	0.467	2008
New Britain Water Department	Valley Water Systems, Inc.	New Britain*	0	2006
New London Dept. Of Public Utilities	East Lyme Water & Sewer Commission*	Waterford	0	2015

Table 2-8 List of Active Interconnections

Supplier	Receiver	Town	Average Day Transfer (mgd)	Year
Norwich Public Utilities	Mohegan Tribal Utility Authority	Montville	0.45	2015
Pleasure Valley M.H.P - System #1	Pleasure Valley M.H.P – System #2	Norwich	0	2013
Pleasure Valley M.H.P - System #2	Pleasure Valley M.H.P – System #3	Norwich	0	2013
Ridgewood Hills Association, System #1	Ridgewood Hills Association, System #2	Deep River	0	2015
Ridgewood Hills Association, System #3	Ridgewood Hills Association, System #4	Deep River	0	2015
SCCRWA	Aquarion - East Derby System	Derby*	0.136	2014
SCCRWA	Aquarion - Hawkstone System	Seymour	0.014	2005
SCCRWA	Aquarion - Valley System	Seymour*	0.069	2005
SCCRWA	Meriden Water Division	Cheshire	0.218	2006
SCCRWA	Meriden Water Division	Cheshire	0.218	2006
SCCRWA	CWC - Guilford System	Guilford	0	2008
Second Norwalk Taxing District	Aquarion - Noroton System	Darien	0.048	2005
Tolland Water Department	CWC – Riversedge Division	Tolland / Willington	0.03	2013
Tolland Water Department	Tolland Water Department – Torry Road	Tolland	0	2012
Torrington Water Company	Aquarion - Litchfield System	Torrington	0.109	2008
Town of East Longmeadow, Mass.	CWC – Crescent Lake System	Enfield	0.035	2006
Waterbury Water Department	CWC – Hillcrest System	Middlebury	0.004	2009
Waterbury Water Department	CWC – Thomaston System	Thomaston	0.018	2006
Waterbury Water Department	CWC – Central System	Waterbury	0	2010
Waterbury Water Department	Watertown Water & Sewer Authority	Watertown*	0.91	2006
Waterbury Water Department	Wolcott Water Department	Waterbury	0.118	2008
Watertown Fire District	Watertown Water & Sewer - Westgate	Watertown	0.012	2009
Willington Ridge Condo – System #2	Willington Ridge Condos – System #1	Willington	0	2015

*Multiple interconnections exist between the two utilities.

**Interconnection only utilized to flush water mains. Demand is negligible on an average day basis.

*Regional Water Banking Project. Water is directed from East Lyme for storage in Lake Konomoc for six months of the year, and then purchased back by East Lyme for six months of the year when demand is highest. The net annual transfer is zero.

**Contractual annual average

**Multiple interconnections, and Main System also provides water to Noroton, New Canaan, and Greenwich systems

Table 2-9 Planned and/or Identified Future Interconnections

Community Water System	Planned and/or Identified Interconnections for Additional Supply
>1000 Served (Large Systems)	
Aquarion Water Company – Berkshire Corporate Park System	Interconnection with Aquarion Water Company – Brookfield System
Aquarion Water Company – Chimney Heights	Interconnection with Aquarion Water Company – Berkshire Corporate Park System
Aquarion Water Company – Main System	Interconnection with Aquarion Water Company – Newtown System
Aquarion Water Company – Ridgefield System	Interconnection with Aquarion Water Company – Ridgefield Knolls System
Aquarion Water Company – Ridgefield System	Interconnection with Danbury Water Department
Aquarion Water Company – Valley System	Interconnection with Aquarion Water Company – Main System
Aquarion Water Company – Western Brookfield System	Interconnection with Aquarion Water Company – Brookfield System
Avon Water Company	Interconnection with MDC
Avon Water Company	Interconnection with Aquarion Water Company – Simsbury System
Berlin Water Control Commission	Interconnection with Meriden Water Division
Berlin Water Control Commission	Interconnection with Southington Water Department
Bethel Water Department	Interconnection with Danbury Water Department
Bristol Water Department	Interconnection with SCCRWA (via Wolcott)
Bristol Water Department	Interconnection with Southington Water Department
Bristol Water Department	Interconnection with Torrington Water Company
Bristol Water Department	Interconnection with MDC
Bristol Water Department	Interconnection with Waterbury Water Department (via Plymouth or Wolcott)
Colchester Water & Sewer Commission	Interconnection with nearby CWC systems, East Hampton WPCA, and/or Norwich Public Utilities
Connecticut Valley Hospital	Interconnection with Middletown Water Department
Cromwell Fire District	Interconnection with MDC
CWC – Central System	Interconnection with Waterbury Water Department
CWC – Central System	Interconnection with SCCRWA
CWC – Chester System	Interconnection with CWC – Guilford System
CWC – Collinsville System	Interconnection with CWC – Unionville System
CWC – Crystal Water Company	Interconnection with CWC – Crystal Plainfield Division
CWC – Gallup Water Service, Inc.	Interconnection with CWC – Crystal Plainfield Division
CWC – Sound View System	Interconnection with CWC – Guilford System
CWC – Sound View System	Interconnection with CWC – Point O' Woods System
CWC – Stafford System	Interconnection with CWC – Western System
CWC – Unionville System	Interconnection with Bristol Water Department
CWC – Western System	Interconnection with Agawam Water Company
CWC – Western System	Interconnection with University of Connecticut

Table 2-9 Planned and/or Identified Future Interconnections

Community Water System	Planned and/or Identified Interconnections for Additional Supply
East Lyme Water & Sewer Commission	Utilize Thames Basin Regional Interconnection and Montville-Waterford Interconnection to bring additional supply along water banking pipeline
Heritage Village Water Company	Interconnection with Waterbury Water Department (via CWC Central System)
Ledyard WPCA (both systems)	Interconnections with nearby SCWA systems
Mashantucket Pequot Tribal Nation	Interconnection with SCWA – North Stonington Division
Meriden Water Department	Interconnection with Kensington Fire District
Meriden Water Department	Interconnection with New Britain Water Department
Middletown Water Department	Interconnection with Durham Center System
Middletown Water Department	Interconnection with Berlin Water Control Commission
Montville Water Supply (WPCA)	Increase transfers through Thames Basin Regional Interconnection
New London Department of Public Utilities	Utilize Thames Basin Regional Interconnection and Montville-Waterford Interconnection to bring additional supply
Norwich Public Utilities	Interconnect with Ledyard WPCA and Montville WPCA via Poquetanuck Cove (Route 12) to access water from Groton Utilities
SCCRWA	Interconnection with Southington Water Department
SCCRWA	Interconnection with Waterbury Water Department
SCCRWA	Interconnection with Aquarion Water Company – Main System
SCWA – Mohegan Division	Interconnection with Montville WPCA
SCWA – Montville Division	Interconnection with SCWA – Seven Oaks Division
SCWA – North Stonington Division	Interconnection with future Town of North Stonington system
Southington Water Department	Interconnection with Bristol Water Department
Southington Water Department	Interconnection with New Britain Water Department
Southington Water Department	Interconnection with South Central Connecticut Regional Water Authority
Sprague Water & Sewer Commission	Interconnection with Norwich Public Utilities
Tarriffville Fire District	Interconnection with Aquarion Water Company – Simsbury System
Town of North Stonington	Interconnection with Aquarion Water Company – Mystic system
Wallingford Water Department	Interconnection with Meriden Water Department
Wallingford Water Department	Interconnection with South Central Connecticut Regional Water Authority
Waterford Utilities Commission	Utilize Thames Basin Regional Interconnection and Montville-Waterford Interconnection to bring additional supply
Westerly Water Department	Interconnection with Aquarion Water Company – Mystic system
Windham Water Works	Interconnection with University of Connecticut or Norwich Public Utilities
Windham Water Works	Interconnection with Norwich Public Utilities
	(at Timber Oaks)

Table 2-9 Planned and/or Identified Future Interconnections

Community Water System	Planned and/or Identified Interconnections for Additional Supply
>1000 Served (Small Systems)	
Aquarion Water Company – Ball Pond System	Investigate potential interconnections
Aquarion Water Company – Birches System	Interconnection with New Fairfield Municipal System
Aquarion Water Company – Birchwood Estates System	Interconnection with Town of Marlborough Town Center water system
Aquarion Water Company – Butternut System	Interconnection with Aquarion Water Company – Brookfield System
Aquarion Water Company – Craigmoor System	Interconnection with Aquarion Water Company – Ridgefield System
Aquarion Water Company – Dean Heights System	Interconnection with Aquarion Water Company – New Milford System
Aquarion Water Company – Dunham Pond System	Interconnection with New Fairfield Municipal System
Aquarion Water Company – Indian Field System	Interconnection with Aquarion Water Company – Brookfield System
Aquarion Water Company – Meadowbrook System	Interconnection with Aquarion Water Company – New Milford System
CWC – Country Mobile Estates System	Interconnection with CWC – Gallup Water Service
CWC – Western System	Interconnection with Jensen's Rolling Hills Residential, S & P Properties LLC, and other small systems in Mansfield
East Hampton WPCA – Future Town-wide System	Interconnection with Colchester Water & Sewer, Middletown Water Department / Pratt & Whitney, and/or Portland Water Department
Ledyard WPCA (both systems)	Interconnection with nearby SCWA systems
Preston Plains Water Company	Increase transfers from Mashantucket Pequot Tribal Nation
SCWA – Barrett Division	Interconnection with Ledyard WPCA
SCWA – Birchwood Division	Interconnection with SCWA – Mohegan or Montville WPCA
SCWA – Cedar Ridge Division	Interconnection with future Town of North Stonington system
SCWA – Chriswood Division	Interconnection with Ledyard WPCA
SCWA – Lantern Hill Division	Interconnection with Aquarion Water Company – Mystic system
SCWA – Ledyard Center Division	Interconnection with SCWA – Grey Farms Division or Ledyard WPCA
Tolland Water Department	Interconnection with Norwegian Woods Apartments (via CWC – Western System)

Table 2-10 Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Community Water System	Planned or Identified Expansions / Alterations to Water Supply Facilities
Aquarion Water Co. – Mystic System	Install redundant Mystic River crossing, additional storage tank to enhance fire protection
Aquarion Water Company – Brookfield System	Interconnection with Chimney Heights system; well development, improvements, and testing; consolidate Western Brookfield, Candlewood Acres, Town Brooke, and Butternut systems, distribution system upgrades
Aquarion Water Company – Chimney Heights	Consolidate Berkshire Corporate Park system, interconnect with Brookfield system
Aquarion Water Company – East Derby System	No planned or identified expansions or alterations
Aquarion Water Company – Greenwich System	Distribution upgrades, dam modifications, water treatment plant upgrades
Aquarion Water Company – Litchfield System	Replace groundwater well
Aquarion Water Company – Main System	Distribution upgrades, dam modifications
Aquarion Water Company – New Canaan System	Distribution upgrades, dam modifications
Aquarion Water Company – New Milford System	Consolidate Litchfield Hills, Dean Heights, Pleasant View, Meadowbrook, Park Glen, Forest Hills, Carmen Hill, Laurel View, and Laurel Ridge systems, distribution system upgrades
Aquarion Water Company – Newtown System	Interconnection upgrades, well site improvements, consolidate Chestnut Tree Hill system
Aquarion Water Company – Norfolk System	Distribution upgrades
Aquarion Water Company – Noroton System	Distribution upgrades, dam modifications
Aquarion Water Company – North Canaan System	Distribution upgrades
Aquarion Water Company – Ridgefield System	Well replacement, pump station upgrades, consolidate Craigmoor and Ridgefield Knolls systems
Aquarion Water Company – Salisbury System	Distribution upgrades, dam modifications
Aquarion Water Company – Simsbury System	Distribution system upgrades, identify/install additional supply sources, create new high-service zone
Aquarion Water Company – Stamford System	Distribution upgrades, dam modifications, water treatment plant upgrade
Aquarion Water Company – Valley System	Distribution upgrades
Aquarion Water Company – Western Brookfield	Consolidate with Brookfield system
Aquarion Water Company – Woodbury System	Well replacement

Table 2-10 Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Community Water System	Planned or Identified Expansions / Alterations to Water Supply Facilities
Avon Water Company	Identify and develop future supply sources, additional storage tanks, distribution system upgrades
Berlin Water Control Commission	Distribution system upgrades, tank improvements, well replacement, identify future sources, identifying interconnection locations with neighboring water systems, upgrade MDC interconnection
Bethel Water Department	Storage upgrades, additional groundwater supplies in East Swamp Brook aquifer, abandonment of surface water supplies, pursue emergency interconnections, pump station upgrades, distribution system upgrades, well replacement
Bristol Water Department	Distribution system upgrades, meter upgrades, well redevelopment, storage upgrades, dam improvements, Southington interconnection, Torrington interconnection
Candlewood Shores Tax District	Distribution system upgrades, pressure upgrades, identify new well location
Colchester Water & Sewer Commission	Continue future source assessment, consider interconnections, water main extensions and replacements
Connecticut Correctional Institute	Identify future sources
Connecticut Valley Hospital	Pursue interconnection
Cromwell Fire District Water Department	Distribution system upgrades, emergency interconnections
CWC – Central System	Distribution system upgrades, storage tank upgrades, evaluate future supply sources
CWC – Chester System	Distribution system upgrades, storage tank upgrades
CWC – Collinsville Sys	Distribution system upgrades, interconnection, future source evaluation
CWC – Crystal Plainfield	Complete Level A Aquifer Protection Area Mapping, miscellaneous distribution system improvements, new storage tank, interconnection with Gallup system and Crystal Water Company system
CWC – Crystal Thompson	Miscellaneous distribution system improvements
CWC – Crystal Water Company	Complete Level A Aquifer Protection Area Mapping, miscellaneous distribution system improvements, new storage tank, consider future source assessment, interconnect with Crystal-Plainfield system
CWC – Gallup Water Service, Inc.	Interconnect Gallup system with Crystal-Plainfield system, installation of high-service main to Industrial Park gradient, replacement of undersized mains, abandonment of inactive supplies, interconnect with Country Mobile Estates system, control unaccounted-for water
CWC – Guilford System	Distribution system upgrades, interconnections, storage tank upgrades, eventual development of new wellfields
CWC – Hebron Center	No identified needs

Table 2-10 Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Community Water System	Planned or Identified Expansions / Alterations to Water Supply Facilities
CWC – Legend Hill Condominium Association	No identified needs
CWC – Point O' Woods	Interconnection
CWC – Sound View	Interconnections
CWC – Stafford System	Distribution system upgrades, dam modifications, future source evaluation
CWC – Terryville System	Distribution system upgrades, storage tank upgrades, future source evaluation
CWC – Thomaston System	Distribution system upgrades, storage tank upgrades
CWC – Unionville System	Distribution system upgrades, storage tank upgrades, interconnection, future source evaluation
CWC – Western System	Distribution system upgrades, storage tank upgrades, Rockville WTP upgrade, other treatment plant/wellfield upgrades, evaluation of future sources, complete Mansfield extension
Danbury Water Department	Distribution system upgrades, future source evaluation, storage tank upgrades
East Lyme Water & Sewer	Install replacement wells, development of regional supply sources, control unaccounted-for water, tank improvements
First Taxing District of the City of Norwalk Water Department	Expansion of system to fill gaps in ESA, identify new well location, water treatment upgrades, distribution system upgrades, tank replacement/maintenance, pump station upgrades, dam rehabilitation, fire protection upgrades, pursue interconnections, meter upgrades
Groton Long Point Association	No major system modifications have been identified.
Groton Utilities	Elevate dam at Ledyard Reservoir, tank replacements, miscellaneous distribution system improvements, consider development of future supplies, construction of satellite treatment plant
Hazardville Water Company	Future source evaluation, interconnection, distribution system upgrades
Heritage Village Water Company	Distribution system upgrades, well rehabilitation, storage tank upgrades, standby power upgrades, additional storage tank
Jewett City Water Company	Distribution system upgrades, activate additional supply sources, possible future interconnection with CWC – Gallup system
Kensington Fire District[1]	Distribution system upgrades, future source evaluation
Ledyard WPCA – Gales Ferry System	Distribution system upgrades, interconnections with SCWA systems
Ledyard WPCA – Ledyard Center System	Distribution system upgrades, interconnections with SCWA systems
Manchester Water Department	Pumping improvements, reservoir improvements, future source evaluation, dam improvements, well redevelopment, distribution system upgrades, storage tank improvements
Mashantucket Pequot Tribal Nation	Install additional wells, water main extensions, consider interconnections

Table 2-10 Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Community Water System	Planned or Identified Expansions / Alterations to Water Supply Facilities
Meriden Water Division	Facility upgrades, distribution system upgrades, future source evaluation
Metropolitan District Commission	Distribution system upgrades, pump station upgrades, future source evaluation, storage tank upgrades
Middletown Water Department	Well replacements/redevelopments, distribution system upgrades, interconnection with Durham
Mohegan Tribal Utility Authority	No major system modifications have been identified.
Montville Water Supply (WPCA)	Increase transfers from Groton Utilities, install wells, install redundant north-south water main, miscellaneous distribution system upgrades
New Britain Water Department	Future source evaluation, pumping station upgrades, distribution system upgrades, storage tank upgrades, dam/reservoir improvements
New Hartford Water Department	Source protection improvements, distribution system upgrades
New London Department of Utilities	Increase available supply (through new sources or improvements to existing sources), distribution system improvements
Noank Fire District	Replace undersized water mains and hydrants, water system extensions
Norwich Public Utilities	Implement filter backwash recycling, development of new wells, potential regional interconnections, distribution system improvements
Portland Water Department	Distribution system upgrades
Putnam WPCA	Revise Level A Aquifer Protection Area mapping, distribution system upgrades
Salmon Brook District Water Department	Interconnection, future source evaluation
SCWA – Mohegan Division	Potential interconnection with Montville WPCA system
SCWA – Montville Division	Potential interconnection with other SCWA systems, additional storage capacity
SCWA – North Stonington Division	Potential interconnection with other water systems, well improvements
SCWA – Tower-Ferry Division	Potential interconnection with Ledyard WPCA system
Second Taxing District City Of Norwalk	Future source evaluation, treatment plant upgrades, distribution system upgrades
South Central Connecticut Regional Water Authority	Watershed protection land acquisitions, dam/reservoir improvements, pump station upgrades, distribution system upgrades, treatment plant upgrades, climate-change-related resiliency improvements, future source evaluation, interconnections
South Central Connecticut Regional Water Authority	Dam/reservoir improvements, pump station upgrades, distribution system upgrades, climate change-related resiliency improvements, future source evaluation, interconnections
Southbury Training School	Well rehabilitation, storage upgrades, meter upgrades, future source evaluation

Table 2-10 Planned and/or Identified Expansions/Alterations for Community Water Systems Serving > 1,000 People

Community Water System	Planned or Identified Expansions / Alterations to Water Supply Facilities
Southington Water Department	Future source evaluation, interconnections, storage tank upgrades, distribution system upgrades
Sprague Water & Sewer Commission	Develop new wells/reactivate surface water supply, potential interconnection with Norwich Public Utilities, water main extension, distribution system upgrades
Tariffville Fire District Water Department	Future source evaluation, storage tank upgrades, interconnection
Tolland Water Department	Future source evaluation, distribution system upgrades
Torrington Water Company	Distribution system improvements, future source evaluation, storage tank upgrades, dam improvements, reservoir land acquisition
Town of Newtown – Fairfield Hills	Well redevelopment, treatment building upgrades, standby power upgrades, future source evaluation, pump station upgrades
University of Connecticut – Main Campus	Interconnection, distribution system upgrades/extensions, subsystem connectivity upgrades, well redevelopment
Valley Water Systems, Inc.	Distribution system upgrades, pumping station upgrades, future source evaluation
Wallingford Water Department	Future source evaluation, distribution system upgrades, pursue interconnections
Waterbury Water Department	Pump station upgrades, storage tank upgrades, dam improvements, distribution system upgrades, water treatment plant upgrades
Waterford Utilities Commission	Distribution system upgrades, identify regional supply sources
Watertown Fire District	Dam improvements, potential well redevelopments, distribution system upgrades, treatment plant upgrades, future source evaluation
Watertown Water & Sewer Authority	Water supply facility upgrades, pumping station upgrades, pressure upgrades, storage tank upgrades, distribution system upgrades
Westerly Water Department	Distribution system upgrades, potential interconnection with Aquarion Water Company – Mystic system
Windham Water Works	Identify additional sources / increase available supply, distribution system improvements
Windham Water Works	Identify additional sources / increase available supply, distribution system improvements
Winsted Water Works	Distribution system upgrades, pressure upgrades, storage tank upgrades, standby power upgrades, dam/dike improvements
Wolcott Water Department	Distribution system expansions/upgrades
Worthington Fire District[1]	Distribution system upgrades

Table 2-11 Potential Future Source of Supply Exploration Planned/Needed for Community Water Systems Serving >1,000 People

Community Water System	None Identified	Within 5-Year Planning Period	Beyond 5-Year Planning Period
Aquarion Water Co. – Mystic System			X
Aquarion Water Company – Brookfield System		X	
Aquarion Water Company – Chimney Heights		X	
Aquarion Water Company – East Derby System	X		
Aquarion Water Company – Litchfield System			X
Aquarion Water Company – Main System			X
Aquarion Water Company – New Milford System	X		
Aquarion Water Company – Newtown System		X	
Aquarion Water Company – Norfolk System	X		
Aquarion Water Company – North Canaan	X		
Aquarion Water Company – Ridgefield System		X	X
Aquarion Water Company – Salisbury System	X		
Aquarion Water Company – Simsbury System			X
Aquarion Water Company – Southwestern Fairfield County Region Systems (Greenwich, New Canaan, Noroton, Stamford)			X
Aquarion Water Company – Valley System	X		
Aquarion Water Company – Western Brookfield		X	
Aquarion Water Company – Woodbury System		X	
Avon Water Company			X
Berlin Water Control Commission		X	X
Bethel Water Department		X	
Bristol Water Department			X
Candlewood Shores Tax District		X	

Table 2-11 Potential Future Source of Supply Exploration Planned/Needed for Community Water Systems Serving >1,000 People

Community Water System	None Identified	Within 5-Year Planning Period	Beyond 5-Year Planning Period
Colchester Water & Sewer Commission		X	X
Connecticut Correctional Institute		X	X
Connecticut Valley Hospital		X	X
Cromwell Fire District Water Department		X	
CWC – Central System			X
CWC – Chester System		X	
CWC – Collinsville Sys		X	
CWC – Crystal Plainfield	X		
CWC – Crystal Thompson	X		
CWC – Crystal Water Company			X
CWC – Gallup Water Service, Inc.			X
CWC – Guilford System		X	X
CWC – Hebron Center	X		
CWC – Legend Hill Condominium Association	X		
CWC – Point O' Woods			X
CWC – Sound View			X
CWC – Stafford System			X
CWC – Terryville System			X
CWC – Thomaston System			X
CWC – Unionville System		X	
CWC – Western System		X	X
Danbury Water Department			X
East Lyme Water & Sewer			X
First Taxing District of the City of Norwalk Water Department			X
Groton Long Point Association	X		
Groton Utilities		X	X
Hazardville Water Company			X
Heritage Village Water Company			X
Jewett City Water Company			X
Kensington Fire District			X
Ledyard WPCA – Gales Ferry System	X		

Table 2-11 Potential Future Source of Supply Exploration Planned/Needed for Community Water Systems Serving >1,000 People

Community Water System	None Identified	Within 5-Year Planning Period	Beyond 5-Year Planning Period
Ledyard WPCA – Ledyard Center System	X		
Manchester Water Department			X
Mashantucket Pequot Tribal Nation			X
Meriden Water Division			X
Metropolitan District Commission			X
Metropolitan District Commission			X
Middletown Water Department		X	X
Mohegan Tribal Utility Authority	X		
Montville Water Supply (WPCA)		X	X
New Britain Water Department			X
New Britain Water Department			X
New Hartford Water Department			X
New London Department of Utilities			X
Noank Fire District	X		
Norwich Public Utilities		X	X
Portland Water Department			X
Putnam WPCA			X
Salmon Brook District Water Department			X
SCCRWA			X
SCCRWA			X
SCWA – Mohegan Division			X
SCWA – Montville Division			X
SCWA – North Stonington Div.			X
SCWA – Tower-Ferry Division			X
Second Taxing District City Of Norwalk			X
Southbury Training School		X	
Southington Water Department			X

Table 2-11 Potential Future Source of Supply Exploration Planned/Needed for Community Water Systems Serving >1,000 People

Community Water System	None Identified	Within 5-Year Planning Period	Beyond 5-Year Planning Period
Sprague Water & Sewer Commission		X	
Tariffville Fire District Water Department	X		
Tolland Water Department	X		
Torrington Water Company			X
Town of Newtown – Fairfield Hills		X	X
University of Connecticut – Main Campus	X		
Valley Water Systems, Inc.			X
Wallingford Water Department			X
Waterbury Water Department	X		
Waterford Utilities Commission			X
Watertown Fire District			X
Watertown Water & Sewer Authority			X
Westerly Water Department			X
Windham Water Works			X
Windham Water Works			X
Winsted Water Works	X		
Wolcott Water Department		X	
Worthington Fire District	X		

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Andover	None	No	0	SW, TT
Ansonia	SCCRWA	Yes	473	DH, CS, TT, SW
Ashford	None	No	-	SW, TT
Avon	Avon Water Company	Yes	648	SW, TT
Avon	CWC – Collinsville & Unionville Systems	Yes	158	
Avon	MDC	Yes	5	
Barkhamsted	None	No	0	2 DH, TT, SW
Beacon Falls	Aquarion Water Company – Valley	Yes	195	DH, TT, SW
Beacon Falls	CWC – Central System	Yes	13	
Berlin	Kensington Fire District	Yes	255	3 DH, 3 CS, SW, TT
Berlin	Berlin Water Control Commission	Yes	545	
Berlin	Worthington Fire District	Yes	153	
Bethany	SCCRWA	Yes	2	SW, TT
Bethany	CWC – Central System	Yes	1	
Bethel	Aquarion Water Company – Chimney Heights	Yes	96	TT, SW
Bethel	Bethel Water Department			
Bethel		Yes	250	
Bethlehem	None	No	0	32 DH, TT, SW
Bloomfield	MDC	Yes	752	SW, TT
Bolton	None	No	0	SW, TT
Bozrah	Norwich Public Utilities	Yes	NR [A]	DH, SW, TT
Branford	SCCRWA	Yes	891	SW, TT

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Bridgeport	Aquarion Water Company – Main System	Yes	2,077	TT, SW
Bridgewater	None	No	0	DH, TT, SW
Bristol	Bristol Water Department	Yes	1550	TT, SW
Bristol	New Britain Water Department	Yes	NR	
Brookfield	Aquarion Water Company – Brookfield	Yes	160	50 DH, TT, SW
Brookfield	Aquarion Water Company – Western Brookfield System	Yes	6	
Brookfield	Candlewood Shores Tax District			
Brookfield		Yes	12	
Brooklyn	CWC – Crystal Water Division	Yes	32	SW, TT
Burlington	Torrington Water Company	Yes	NR [A]	DH, TT
Burlington	CWC – Collinsville System	Yes	3	
Canaan	Aquarion Water Company – Norfolk	Yes	10	SW, TT
Canterbury	None	No	-	SW, TT
Canton	CWC – Collinsville System	Yes	201	SW, TT
Canton	MDC	Yes	3	
Chaplin	None	No	-	SW, TT
Cheshire	SCCRWA	Yes	1,190	None
Chester	CWC – Chester System	Yes	55	SW, TT
Clinton	CWC – Guilford System	Yes	291	SW, TT
Colchester	Colchester Sewer & Water Comm.	Yes	209	BT, DH, SW, TT
Colebrook	None	No	0	SW, TT

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Columbia	None	No	0	SW, TT
Cornwall	None	No	0	DH, CS, TT, SW
Coventry	None	No	0	SW, TT
Cromwell	Cromwell Fire District Water	Yes	737	SW, TT
Cromwell	MDC	Yes	1	
Danbury	Danbury Water Department	Yes	NR	TT, SW
Darien	Aquarion Water Company - Noroton	Yes	554	TT, SW
Deep River	CWC – Chester System	Yes	47	SW, TT
Derby	SCCRWA	Yes	355	DH, CS, TT, SW
Derby	Aquarion Water Company – East Derby	Yes	49	
Durham	None	No	0	SW, TT
East Granby	Aquarion Water Company – Simsbury	Yes	10	SW, TT
East Granby	MDC	Yes	65	
East Granby	CWC – Western System	No	0	
East Haddam	None	No	0	SW, TT
East Hampton	None	No	0	SW, TT
East Hartford	MDC	Yes	1,073	SW, TT
East Haven	SCCRWA	Yes	626	DH, CS, SW, TT
East Lyme	East Lyme Water & Sewer Commission	Yes	732	CS, DH, SW, TT
East Windsor	CWC – Western System	Yes	328	SW, TT
East Windsor	Hazardville Water Company	Yes	3	
Eastford	None	No	-	SW, TT
Easton	Aquarion Water Company – Main System	Yes	186	TT, SW
Ellington	CWC – Western System	Yes	284	SW, TT
Enfield	CTWC – Western System	Yes	350	SW, TT
Enfield	Hazardville Water Company	Yes	605	
Enfield	Connecticut Correctional Institute	Yes	NR	
Essex	CWC – Chester System	Yes	126	SW, TT

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Fairfield	Aquarion Water Company – Main System	Yes	1,579	TT, SW
Farmington	CWC – Unionville System	Yes	861	SW, TT
Farmington	MDC	Yes	105	
Farmington	New Britain Water Department	Yes	NR	
Farmington	Valley Water Systems	Yes	4	
Franklin	Norwich Public Utilities	Yes	NR [A]	DH, SW
Glastonbury	MDC	Yes	711	SW, TT
Glastonbury	Manchester Water Department	Yes	65	
Goshen	Aquarion Water Company – Litchfield	Yes	1	TT, SW
Granby	Aquarion Water Company – Simsbury	Yes	18	DH, SW, TT
Greenwich	Aquarion Water Company – Greenwich	Yes	1,028	TT , SW
Griswold	Jewett City Water Company	Yes	115	2 BT, 10 DH, SW
Groton	Groton Utilities	Yes	767	DH, SW, TT
Groton	Noank Fire District	Yes	83	
Groton	Groton Long Point Association	Yes	32	
Groton	Aquarion Water Company – Mystic	Yes	180	
Guilford	CWC – Guilford System	Yes	373	DH, CS, SW, TT
Haddam	None	No	0	SW, TT
Hamden	SCCRWA	Yes	1,162	SW, TT
Hampton	None	No	-	SW, TT
Hartford	MDC	Yes	2,610	SW, TT
Hartland	None	No	0	BT, TT, SW
Harwinton	Torrington Water Company	Yes	NR [A]	TT, SW
Hebron	CWC – Hebron Center Division	Yes	24	DH, SW, TT
Kent	None	Yes	0	DH, TT, SW
Killingly	CWC – Crystal Water Company	Yes	87	SW, TT
Killingworth	None	No	0	SW, TT
Lebanon	None	No	-	CS, DH, SW, TT
Ledyard (includes Mashantucket)	SCWA, Tower Ferry View Division	No	0	DH, SW, TT
Ledyard (includes Mashantucket)	Mashantucket Pequot Tribal Nation	Yes	NR	

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Ledyard (includes Mashantucket)	Ledyard WPCA, Gales Ferry	Yes	161	
Ledyard (includes Mashantucket)	Ledyard WPCA, Ledyard Center	Yes	33	
Lisbon	Jewett City Water Company	Yes	34	7 DH, SW, TT
Lisbon	Norwich Public Utilities	Yes	NR [A]	
Litchfield	Aquarion Water Company – Litchfield	Yes	140	TT, SW
Lyme	None	No	0	SW, TT
Madison	CWC – Guilford System	Yes	239	SW, TT
Madison	CWC – Legend Hill Condominium Association	NR	NR	
Madison				
Manchester	Manchester Water Department	Yes	1,954	SW, TT
Manchester	MDC	Yes	2	
Mansfield	University of Connecticut	Yes	NR	DH, SW, TT
Mansfield	Windham Water Works	Yes	32+	
Marlborough	None	No	0	SW, TT
Meriden	Meriden Water Division	Yes	1,778	CS, SW, TT
Middlebury	Heritage Village Water Company	Yes	NR [B]	DH, TT, SW
Middlebury	CWC – Central System	Yes	188	
Middlefield	Middletown Water Department	Yes	NR	SW, TT
Middletown	Middletown Water Department	Yes	NR	SW, TT
Middletown	Connecticut Valley Hospital	Yes	81	
Milford	SCCRWA	Yes	1,695	SW, TT
Monroe	Aquarion Water Company – Main System	Yes	478	TT, SW
Montville (includes Mohegan)	SCWA, Montville Division	No	0	DH, SW, TT
Montville (includes Mohegan)	SCWA, Mohegan Division	No	0	
Montville (includes Mohegan)	Montville Water Supply (WPCA)	Yes	119	
Montville (includes Mohegan)	Mohegan Tribal Utility Authority	Yes	NR	
Montville (includes Mohegan)	Norwich Public Utilities	Yes	NR [A]	
Morris	None	No	0	TT, SW

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Naugatuck	CTWC – Central System	Yes	679	CS, TT, SW
New Britain	New Britain Water Department	Yes	NR	SW, TT
New Canaan	Aquarion Water Company – Main System	Yes	306	TT, SW
New Canaan	First Taxing District of the City of Norwalk	Yes	NR [C]	
New Fairfield	None	No	0	DH, CS, TT, SW
New Hartford	Torrington Water Company	Yes	NR [A]	DH, CS, TT, SW
New Hartford	New Hartford Water Department	Yes	65	
New Haven	SCCRWA	Yes	2,197	SW, TT
New London	New London Dept. of Public Utilities	Yes	NR	TT
New Milford	Aquarion Water Company – New Milford	Yes	175	DH, TT, SW
Newington	MDC	Yes	728	SW, TT
Newington	New Britain Water Department	Yes	NR	
Newtown	Aquarion Water Company – Main	Yes	4	DH, CS, TT, SW
Newtown	Aquarion Water Company – Newtown	Yes	223	
Newtown	Town of Newtown – Fairfield Hills	Yes	48	
Norfolk	Aquarion Water Company - Norfolk	Yes	80	TT, SW
North Branford	SCCRWA	Yes	248	SW, TT
North Canaan	Aquarion Water Company – North Canaan System	Yes	79	DH, TT, SW
North Haven	SCCRWA	Yes	834	SW, TT
North Stonington	SCWA, North Stonington Division	No	0	DH, SW, TT
Norwalk	Aquarion Water Company – Main System	Yes	8	TT , SW
Norwalk	First Taxing District of the City of Norwalk	Yes	896 [C]	
Norwalk	South Norwalk Electric & Water	Yes	674	
Norwich	Norwich Public Utilities	Yes	1,322 [A]	DH, SW, TT
Old Lyme	CWC – Point O' Woods	No	0	SW, TT
Old Lyme	CWC – Sound View	Yes	40	

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Old Saybrook	CWC – Guilford System	Yes	373	DH, SW, TT
Orange	SCCRWA	Yes	573	SW, TT
Oxford	Aquarion Water Company – Valley	Yes	43	DH, TT, CS
Oxford	Heritage Village Water Company	Yes	NR [B]	
Plainfield	CTWC – Gallup Water Service, Inc.	Yes	95	SW, TT
Plainfield	CTWC, Crystal – Plainfield Division	Yes	39	
Plainville	Valley Water Systems	Yes	487	SW, TT
Plymouth	CWC – Terryville System	Yes	333	TT, DH, CS, SW
Pomfret	None	No	-	SW, TT
Portland	Portland Water Department	Yes	NR	SW, TT
Preston	Norwich Public Utilities	Yes	NR [A]	19 DH, SW, TT
Prospect	CWC – Central System	Yes	135	DH, TT, SW
Prospect	SCCRWA	Yes	1	
Putnam	Putnam WPCA	Yes	263	SW, TT
Putnam	CWC – Crystal Water Company	Yes	1	
Redding	Aquarion Water Company – Main System	Yes	25	DH, TT, SW
Ridgefield	Aquarion Water Company – Ridgefield	Yes	387	DH, CS, TT, SW
Rocky Hill	MDC	Yes	602	SW, TT
Roxbury	None	No	0	DH, CS, TT, SW
Salem	None	No	-	DH, SW, TT
Salisbury	Aquarion Water Company – Salisbury	Yes	113	DH, CS, TT, SW
Scotland	None	No	-	SW, TT
Seymour	Aquarion Water Company – Valley	Yes	339	DH, CS, TT, SW
Seymour	SCCRWA	Yes	26	
Sharon	None	No	0	TT, SW
Shelton	Aquarion Water Company – Main System	Yes	1,296	DH, CS, TT, SW
Sherman	None	No	0	TT, SW
Simsbury	Aquarion Water Company – Simsbury	Yes	551	SW, TT
Simsbury	Tariffville Fire District Water Dept.	Yes	43	
Simsbury	Avon Water Company	Yes	NR [A]	
Somers	CWC – Western System	Yes	89	DH, CS, SW, TT

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Somers	Hazardville Water Company	Yes	98	
South Windsor	CWC – Western System	Yes	736	SW, TT
South Windsor	MDC	Yes	277	
South Windsor	Manchester Water Department	Yes	4	
Southbury	Heritage Village Water Company	Yes	575 [B]	CS, TT, SW
Southbury	Southbury Training School	Yes	67	
Southington	Southington Water Department	Yes	1,766	SW, TT, DH
Southington	New Britain Water Department	Yes	NR	
Southington	Valley Water Systems	Yes	26	
Sprague	Sprague Water & Sewer Authority	Yes	37	9 DH, SW, TT
Stafford	CWC – Stafford System	Yes	75	SW, TT
Stamford	Aquarion Water Company – Stamford	Yes	1,897	TT, SW
Sterling	None	No	-	SW, TT
Stonington	Aquarion Water Company – Mystic	Yes	243	CS, DH, SW, TT
Stonington	Westerly Water Department	Yes	870 [B]	
Stratford	Aquarion Water Company – Main System	Yes	1,406	TT, SW
Suffield	CWC – Western System	Yes	334	SW, TT
Thomaston	CWC – Thomaston System	Yes	142	TT, SW
Thompson	CWC - Thompson Division	Yes	32	SW, TT
Tolland	CWC – Western System	Yes	41	SW, DH, TT
Tolland	Tolland Water Department	Yes	97	
Torrington	Torrington Water Company	Yes	947 [A]	TT, SW
Torrington	Aquarion Water Company – Litchfield	Yes	3	
Trumbull	Aquarion Water Company – Main System	Yes	1,301	TT, SW
Union	None	No	-	SW, TT
Vernon	CWC – Western System	Yes	524	SW, TT
Vernon	Manchester Water Department	Yes	3	

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]
Voluntown	None	No	-	7 DH, SW, TT
Wallingford	Wallingford Water Department	Yes	1699	SW, TT
Warren	None	No	0	13 DH, TT, SW
Washington	None	No	0	DH, TT, SW
Waterbury	Waterbury Water Department	Yes	2,930	TT, SW
Waterbury	CWC – Central System	Yes	14	
Waterford	Waterford Utilities Commission	Yes	NR	BT, SW, TT
Watertown	Watertown Fire District	Yes	NR	12 DH, TT, SW
Watertown	Watertown Water & Sewer Authority	Yes	712	
West Hartford	MDC	Yes	1,403	SW, TT
West Haven	SCCRWA	Yes	940	SW, TT
Westbrook	CWC – Guilford System	Yes	213	SW, TT
Weston	Aquarion Water Company – Main System	Yes	14	TT, SW
Westport	Aquarion Water Company – Main System	Yes	1,098	TT, SW
Westport	First Taxing District of the City of Norwalk	Yes	NR [C]	
Wethersfield	MDC	Yes	781	SW, TT
Willington	None	No	0	SW, TT
Wilton	Aquarion Water Company – Main	Yes	232	TT, SW
Wilton	First Taxing District of the City of Norwalk	Yes	NR [C]	
Wilton	South Norwalk Electric & Water	Yes	51	
Winchester	Winsted Water Works	Yes	356	TT, SW
Windham	Windham Water Works	Yes	752 [C]	CS, DH, SW, TT
Windsor	MDC	Yes	1,095	SW, TT
Windsor Locks	CWC – Western System	Yes	357	SW, TT
Wolcott	Wolcott Water Department	Yes	150	TT, SW
Wolcott	SCCRWA	Yes	25	
Woodbridge	SCCRWA	Yes	92	SW, TT
Woodbury	Aquarion Water Company – Woodbury	Yes	54	DH, CS, TT, SW
Woodstock	Putnam WPCA	Yes	3	SW, TT

1. NR – Not Reported

2. Other Fire Protection Codes: SW = Surface Water; TT = Tanker Trucks; DH = Dry Hydrants; CS = Cisterns;

Table 2-12 Firefighting Capabilities by Municipality

Municipality	Name of Community Water System(s) Serving > 1,000 People	Provides Municipal / Private Fire Protection	Number of Hydrants[1]	Other Municipal Fire Protection[2]

BT = Brush Trucks

Western WUCC Notes

A. Torrington Water Company has fire hydrants in Torrington, Burlington, Harwinton, and New Hartford. The value for Torrington is the combined total for Torrington and the other service communities.

B. The Heritage Village Water Company serves Southbury, Middlebury, and Oxford. The reported hydrant total for Southbury is the combined total for the entire system.

C. The First Taxing District of the City of Norwalk Water Department serves Norwalk, New Canaan, Westport, and Wilton. The reported hydrant total for Norwalk is the combined total for the entire system.

Central WUCC Notes

A. The Avon Water Company hydrant count for Avon includes hydrants in Simsbury.

Eastern WUCC Notes

A. NPU has fire hydrants in Bozrah, Montville, Preston, Lisbon, and Franklin although exact counts are not available. The value for Norwich is the combined total for Norwich and the other NPU service communities.

B. The Westerly Water Department is divided between Stonington and Westerly, RI, with the majority of the system in Westerly. The reported hydrant total is the combined total for the entire system.

C. Windham Water Works is divided between Windham and Mansfield, with the majority of the system in Windham. The reported hydrant total is the combined total for the entire system.

APPENDIX E

Basin Summary Sheets

The regional basin water summaries provide useful information with regard to the amount and use of water within each basin, both now and in the future. Summaries are provided for all of Connecticut's 44 regional basins. This User's Guide was developed to help the reader understand and interpret the information presented in the basin water summaries. Sections 2 and 3 of the Plan include additional information about these water basin summaries.

This section provides the regional basin name, two-digit identifier, major basin which it is located in and the size (in square miles) of the regional basin within CT. Some regional basins extend into surrounding states. That area is not included here.

This section provides a summary of the water inventory which reflects current average annual conditions. Values are shown in both inches per year (in/yr), to facilitate comparison between basins, and million gallons per day (MGD). The inventory only accounts for water within the CT portion of any regional basin that extends into another state.

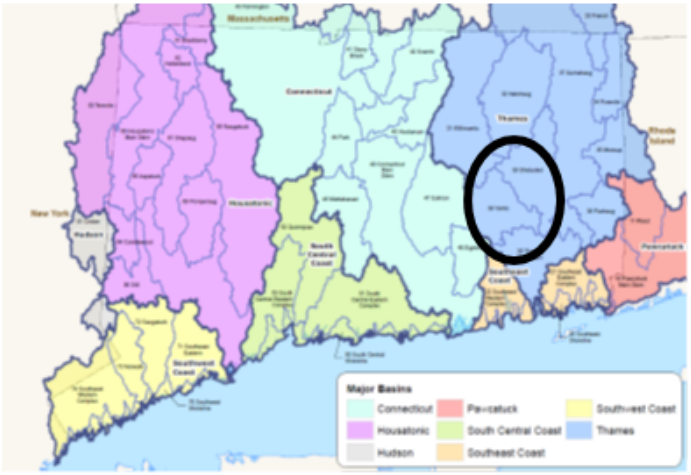
This section provides a map showing the location of the regional basin.

Basin Water Summary

Regional Basin	**Yantic**
Regional Basin No.	**39**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**98**

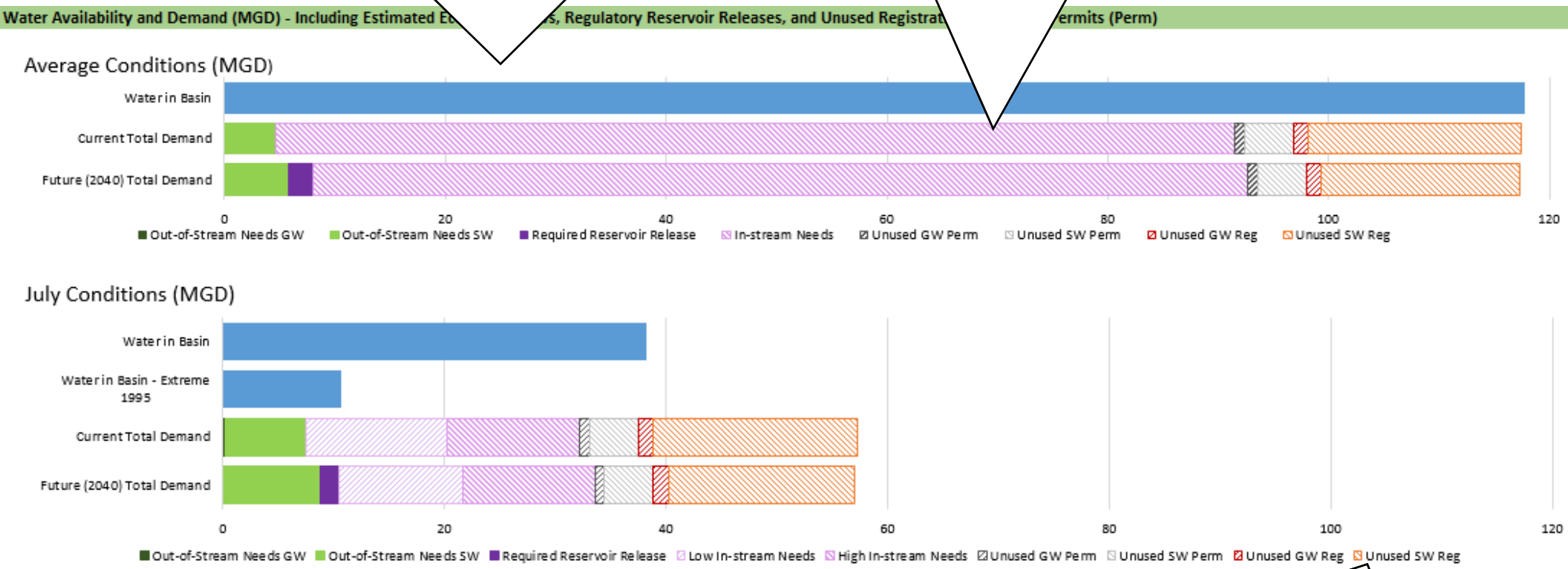
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	48.8	227	Water In
Wastewater Discharge	0.7	3.4	
Estimated Domestic Recharge	0.2	0.7	
Evapotranspiration	22.7	106	Water Out
Groundwater Withdrawals	0.2	0.8	
Surface Water Withdrawals	1.0	4.5	
Stormflow	12.4	58	Internal
Estimated Potential Recharge (EPR)	12.9	60	
Total Streamflow (Stormflow + EPR)	25.3	118	



The top bar chart presents and compares the amount of water in each regional basin for average annual conditions, to current and future surface water and groundwater demands (as total demand). By comparing the length of the blue bar, representing water in the basin to the demand bars, you can see how much water is being used now, and in the future, relative to the amount of water in the basin. Where a light blue bar is also present, it accounts for water that originates outside of CT.

The purple bars present the estimated amount of water needed for in-stream uses. The solid purple bars equal the amount required by reservoir releases under current agreements and future regulations. The hashed purple bar represents a target flow estimated using the USGS Streamstats Program. The Q50 (median flow) is presented for average conditions and a range based on Q80 (low, light purple) and Q50 (high, dark purple) is provided for July conditions.



The bottom bar chart presents and compares the amount of water in each regional basin for July conditions, to current and future surface water and groundwater demands (as total demand). July conditions represent the time of the year when demand is typically at its peak, and water availability is at or near its lowest. The "Water in Basin – Extreme" refers to the lowest July streamflow over the entire period of record used (1985-2015 typically). The year reported is the year of the lowest July streamflow on record.

Because some registered diversions and permits are for volumes greater that what is currently being used, the black, gray, red and orange hashed bars represent the total current and future "unused" amount of groundwater and surface water. This unused portion is calculated as the difference between the sum of all permits and registrations in the regional basin, and the sum of demands. This is shown to compare the total registration and permit amounts to water in the basin. In some instances the total demands, including the unused amounts, exceed the amount of water in the basin (as shown in this example).

Values are provided for four different conditions. ADD refers to average daily demands. MMADD refers to the maximum month average daily demands, or in other words, the month of the year when demands are typically highest. Future conditions refer to year 2040. Demand estimates were prepared based on projected growth (or decline) through year 2040.

This section presents surface water demands. Out-of-stream needs are generally for public water supply but also include all other demands which reflect a withdrawal from a reservoir, stream or river. Current reservoir releases include required releases from existing agreements, where data is available. Future reservoir releases include the current requirements plus estimated minimum streamflow releases that are currently being rolled-out across the state, per the 2011 update to the Minimum Streamflow Rules. In-stream needs are an estimated ecological target based on streamflows calculated using the USGS Streamstats Program. The release amounts are not intended to necessarily represent ideal or total flow needed for aquatic ecological health.

This section presents the total current and future "unused" amount of groundwater and surface water, which is the difference between the sum of all permits and registrations in the regional basin, and the sum of demands.

	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	118	0.09	4.54	NA	86.9		0.86	1.33	4.40	19.34
Future (2040) Conditions, ADD		-0.14	5.82	2.17	86.9		0.86	1.33	4.40	18.06
Current Conditions, MMADD	38	0.27	7.22	NA	12.8	24.8	0.86	1.33	4.40	18.41
Future (2040) Conditions, MMADD		0.05	8.79	1.58	12.8	24.8	0.86	1.33	4.40	16.83

Notes:

1. Average Daily Demand (ADD) is the averag stimated water withdraw m the system on any day in the year.
2. Maximum Monthly Average Daily Deman MADD) is the average esti daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for t ference between groundwa draws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water or g within the basin (CT port Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to t July streamflow on record eriod 1985-2015.
5. Required Reservoir Releases reflect Minimum and Multi Level R mounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for av l conditions, and a range is y conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

Disclaimer: This Water Basin Summa rt of a State-wide screening t nded to be used as stand-alone guidance.

This column presents the estimated amount of water in the basin. It is equal to total, natural streamflow. In some basins, the lack of natural streamflow data required the use of streamflow data from gages in adjacent, similar basins. Several basins include an additional column with out-of-state inflow. In these basins, the estimated out-of-state contribution was judged accessible and capable of supporting all water uses (Class A).

This column presents estimated net groundwater demands. Net groundwater demands are calculated by totaling groundwater demands from community water systems, domestic wells, and other wells (e.g. irrigation for agriculture), then subtracting the amount of water that is estimated to be returned through onsite wastewater treatment systems. In some cases, the net demands are negative, which indicates that a regional basin may not be heavily sewered, and water that comes from a surface water source is being returned through onsite wastewater treatment systems.

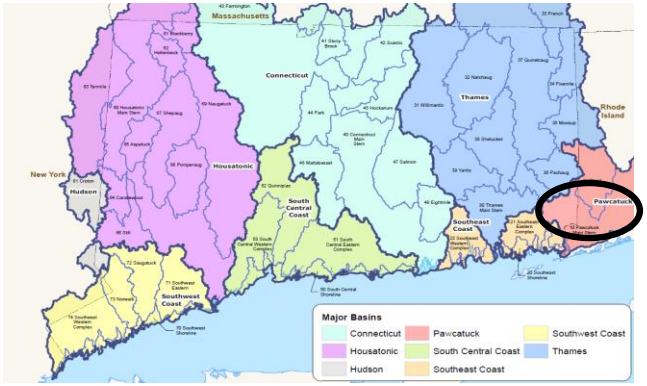
Notes provided at the bottom provide additional information that is useful for interpreting and understanding the water basin summaries.

Basin Water Summary

Regional Basin	**Pawcatuck Main Stem**
Regional Basin No.	**10**
Major Basin	**Pawcatuck**
Size of Basin in CT (mi^2)	**47**

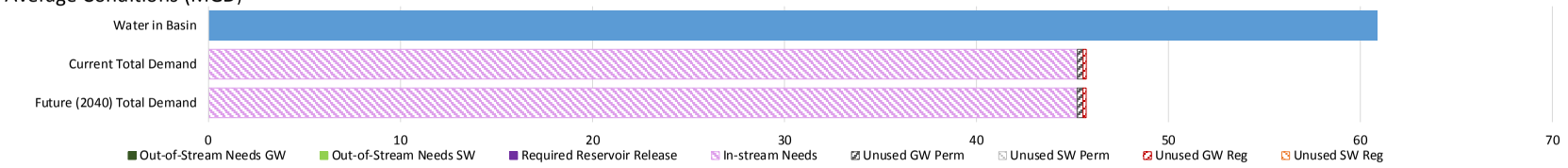
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	52.0	116	Water In
Wastewater Discharge	0.2	0.5	
Estimated Domestic Recharge	0.1	0.3	
Evapotranspiration	22.7	51	Water Out
Groundwater Withdrawals	0.1	0.3	
Surface Water Withdrawals	0.0	0.0	
Stormflow	9.3	21	Internal
Estimated Potential Recharge (EPR)	18.0	40	
Total Streamflow (Stormflow + EPR)	27.3	61	

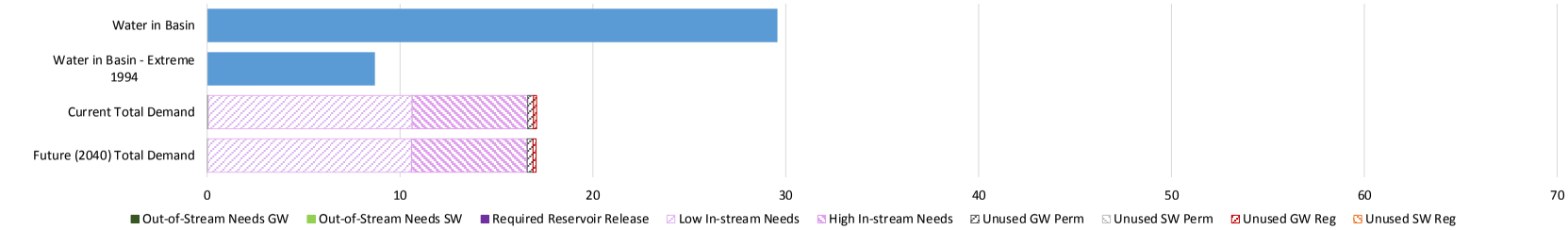


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	61	0.01	0.00	NA	45.2		0.30	0.16	0.00	0.00
Future (2040) Conditions, ADD		-0.01	0.00	0.00	45.2		0.31	0.16	0.00	0.00
Current Conditions, MMADD	30	0.06	0.00	NA	10.6	16.6	0.30	0.16	0.00	0.00
Future (2040) Conditions, MMADD		0.03	0.00	0.00	10.6	16.6	0.30	0.16	0.00	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

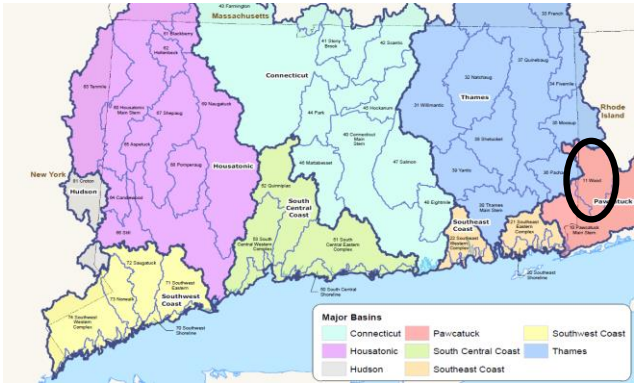
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

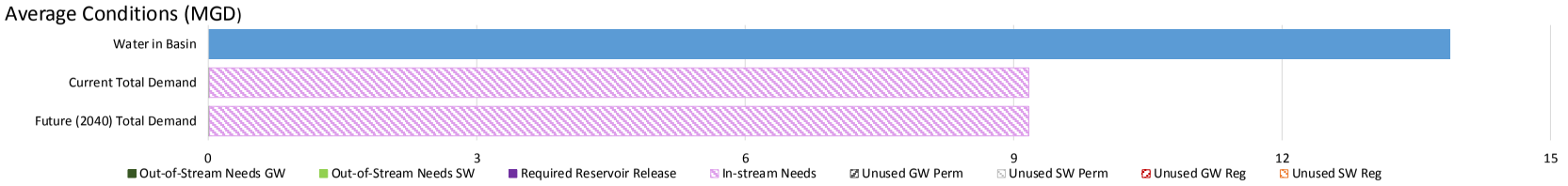
Regional Basin	**Wood**
Regional Basin No.	**11**
Major Basin	**Pawcatuck**
Size of Basin in CT (mi^2)	**10**

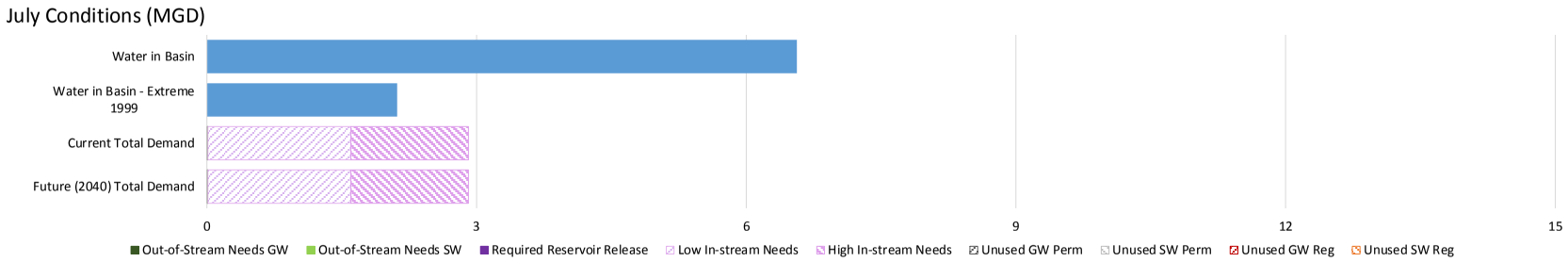
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	50.9	25	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.0	0.0	
Evapotranspiration	22.6	11	Water Out
Groundwater Withdrawals	0.1	0.0	
Surface Water Withdrawals	0.0	0.0	
Stormflow	10.2	5	Internal
Estimated Potential Recharge (EPR)	18.4	9	
Total Streamflow (Stormflow + EPR)	28.6	14	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	14	0.01	0.00	NA	9.2		0.00	0.00	0.00	0.00
Future (2040) Conditions, ADD		0.01	0.00	0.00	9.2		0.00	0.00	0.00	0.00
Current Conditions, MMADD	7	0.01	0.00	NA	1.6	2.9	0.00	0.00	0.00	0.00
Future (2040) Conditions, MMADD		0.01	0.00	0.00	1.6	2.9	0.00	0.00	0.00	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

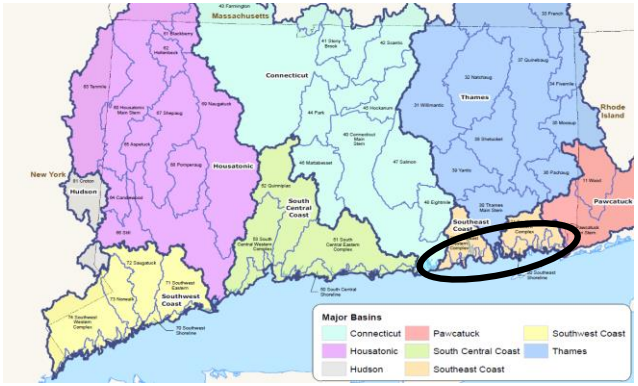
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Basin Water Summary

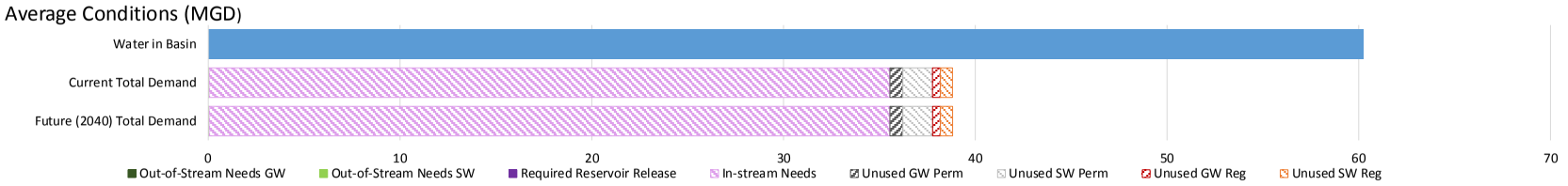
Regional Basin	**Southeast Shoreline**
Regional Basin No.	**20**
Major Basin	**Southeast Coast**
Size of Basin in CT (mi^2)	**43**

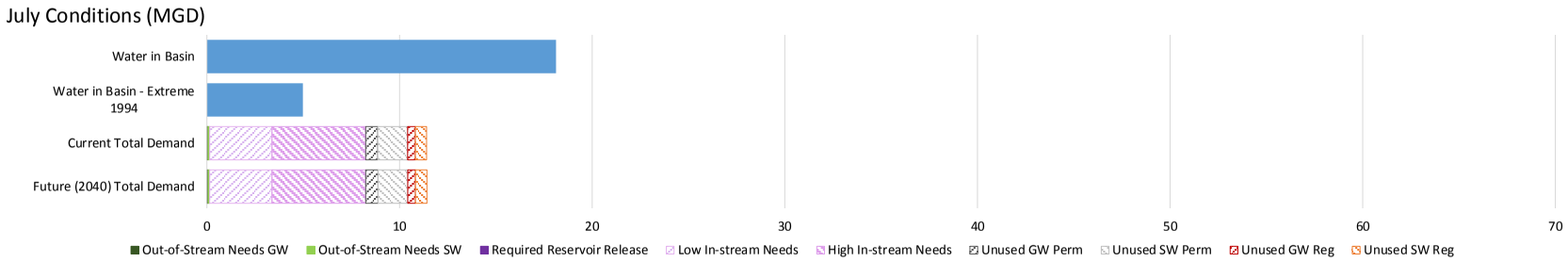
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.1	100	Water In
Wastewater Discharge	1.6	3.3	
Estimated Domestic Recharge	0.3	0.7	
Evapotranspiration	22.9	47	Water Out
Groundwater Withdrawals	0.2	0.3	
Surface Water Withdrawals	0.0	0.0	
Stormflow	12.5	25	Internal
Estimated Potential Recharge (EPR)	17.2	35	
Total Streamflow (Stormflow + EPR)	29.7	60	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	60	-0.33	0.04	NA	35.5		0.67	0.41	1.55	0.63
Future (2040) Conditions, ADD		-0.36	0.04	0.00	35.5		0.67	0.41	1.55	0.63
Current Conditions, MMADD	18	0.06	0.08	NA	3.2	8.1	0.63	0.40	1.55	0.59
Future (2040) Conditions, MMADD		0.06	0.08	0.00	3.2	8.1	0.63	0.40	1.55	0.59

Notes:

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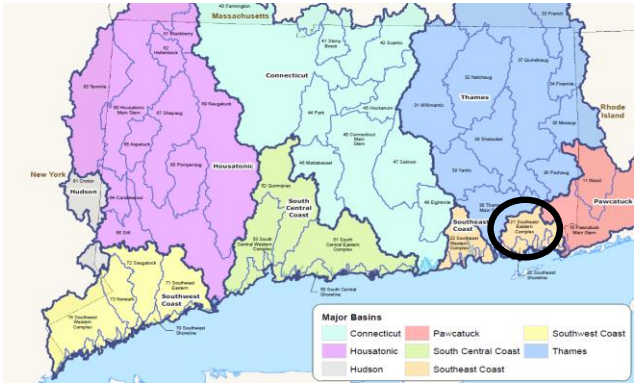
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

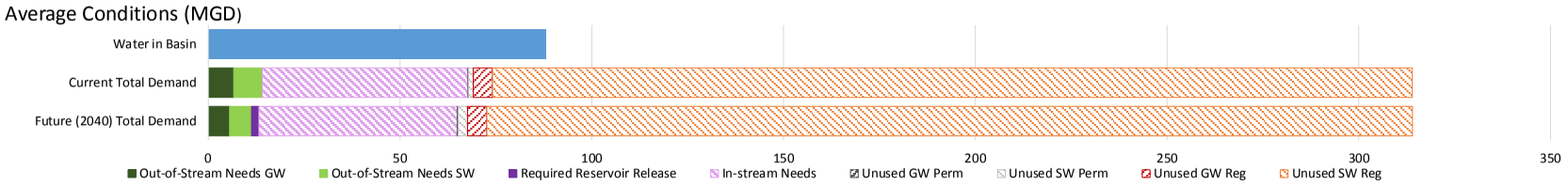
Regional Basin	**Southeast Eastern**
Regional Basin No.	**21**
Major Basin	**Southeast Coast**
Size of Basin in CT (mi^2)	**62**

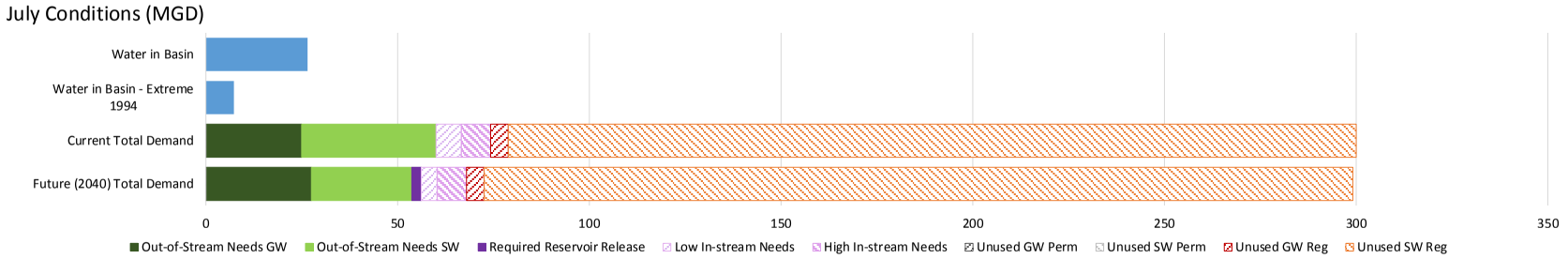
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	50.1	149	Water In
Wastewater Discharge	0.0	0.1	
Estimated Domestic Recharge	0.3	0.8	
Evapotranspiration	22.8	68	Water Out
Groundwater Withdrawals	2.5	7.4	
Surface Water Withdrawals	2.5	7.5	
Stormflow	11.5	34	Internal
Estimated Potential Recharge (EPR)	18.2	54	
Total Streamflow (Stormflow + EPR)	29.7	88	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	88	6.61	7.47	NA	53.6		0.14	5.01	1.25	239.86
Future (2040) Conditions, ADD		5.55	5.72	1.93	53.6		0.30	5.02	2.42	241.39
Current Conditions, MMADD	27	24.98	35.04	NA	6.6	14.3	-4.16	4.58	-13.11	221.17
Future (2040) Conditions, MMADD		27.53	26.17	2.47	6.6	14.3	-3.63	4.63	-8.98	226.54

Notes:

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6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

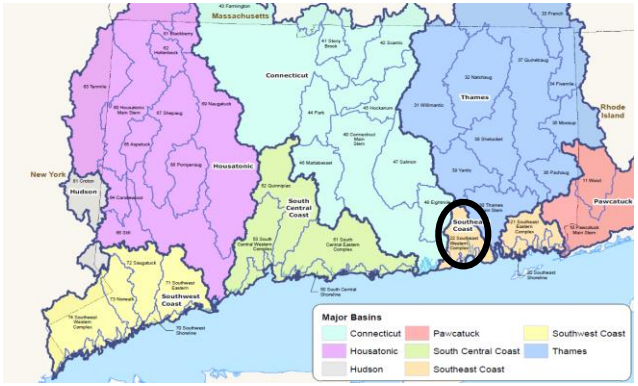
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Basin Water Summary

Regional Basin	**Southeast Western**
Regional Basin No.	**22**
Major Basin	**Southeast Coast**
Size of Basin in CT (mi^2)	**58**

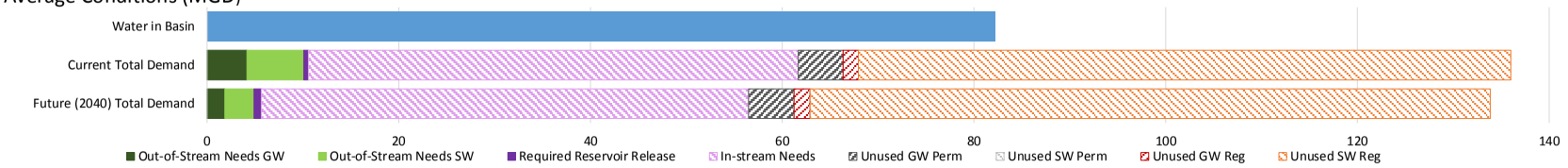
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	48.0	133	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.2	0.5	
Evapotranspiration	22.9	63	Water Out
Groundwater Withdrawals	1.7	4.7	
Surface Water Withdrawals	2.1	5.9	
Stormflow	14.5	40	Internal
Estimated Potential Recharge (EPR)	15.2	42	
Total Streamflow (Stormflow + EPR)	29.7	82	

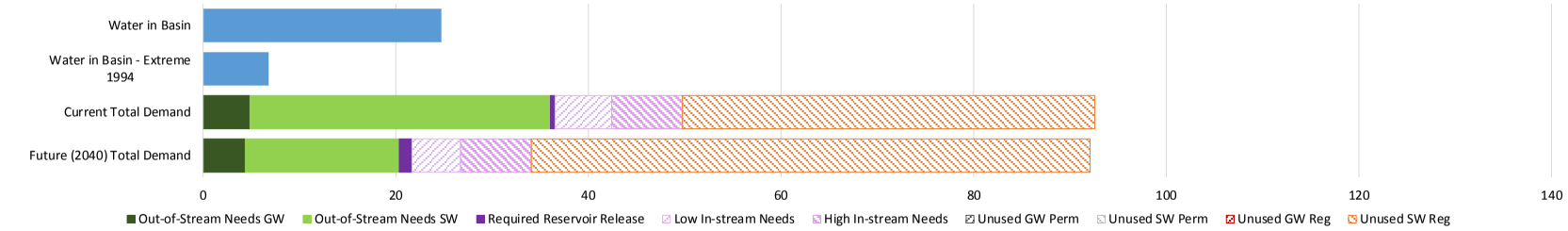


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	82	4.15	5.94	0.48	51.6		4.67	1.60	0.00	68.06
Future (2040) Conditions, ADD		1.86	3.05	0.76	51.6		4.75	1.67	0.00	70.96
Current Conditions, MMADD	25	4.86	31.20	0.48	6.4	13.7	-0.57	-3.07	0.00	42.82
Future (2040) Conditions, MMADD		4.38	15.99	1.32	6.4	13.7	-0.29	-2.82	0.00	58.02

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

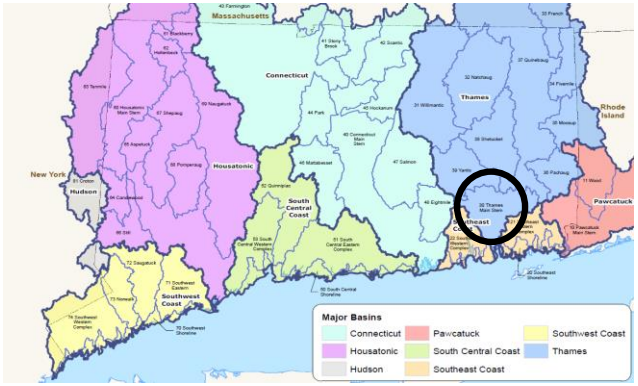
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Thames Main Stem**
Regional Basin No.	**30**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**108**

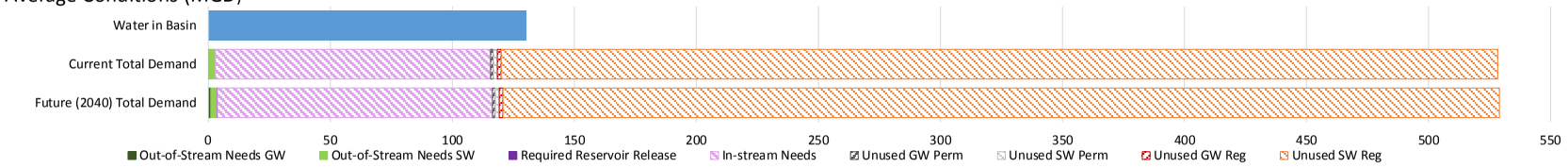
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.0	251	Water In
Wastewater Discharge	7.7	39.5	
Estimated Domestic Recharge	0.3	1.5	
Evapotranspiration	22.8	117	Water Out
Groundwater Withdrawals	0.4	2.1	
Surface Water Withdrawals	0.5	2.4	
Stormflow	11.6	59	Internal
Estimated Potential Recharge (EPR)	13.8	71	
Total Streamflow (Stormflow + EPR)	25.4	130	

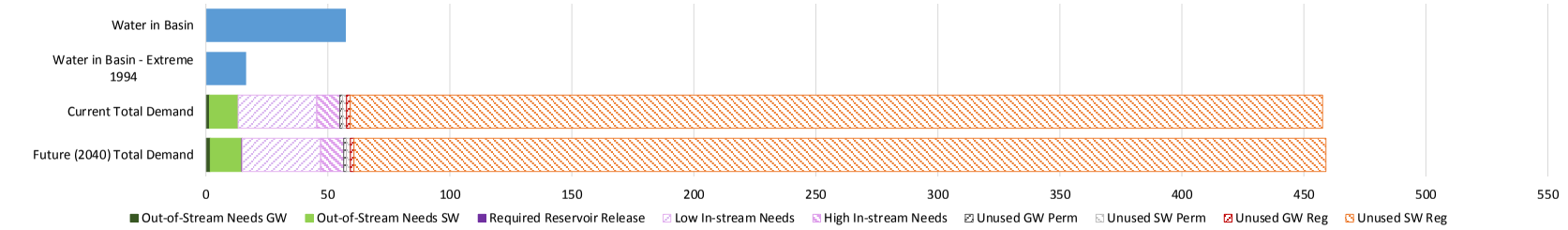


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	130	0.51	2.41	NA	112.7		1.16	1.58	1.62	408.33
Future (2040) Conditions, ADD		1.04	2.66	0.02	112.7		1.15	1.54	1.62	408.31
Current Conditions, MMADD	57	1.46	11.74	NA	32.3	41.7	1.15	1.54	1.62	398.47
Future (2040) Conditions, MMADD		1.81	12.95	0.07	32.3	41.7	1.14	1.50	1.62	398.36

Notes:

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4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
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6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

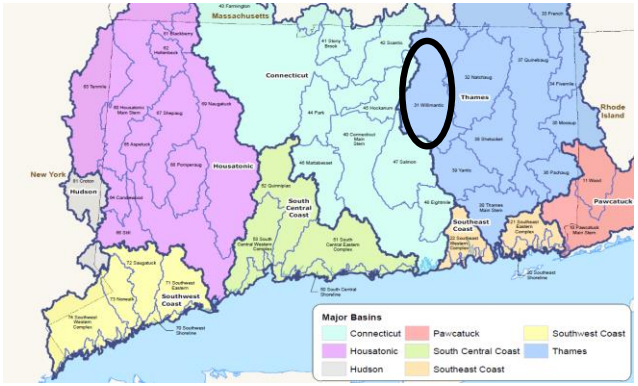
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Basin Water Summary

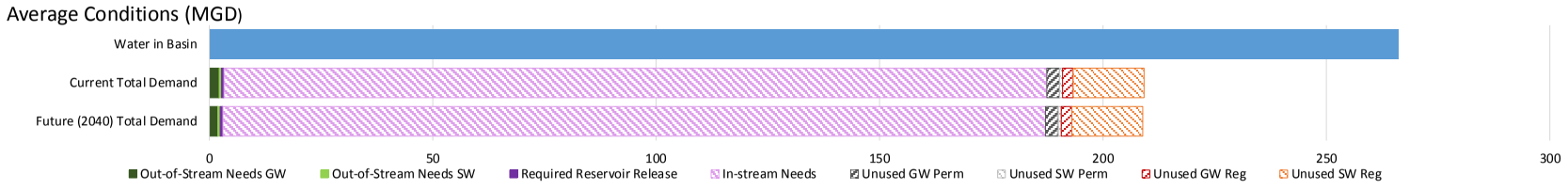
Regional Basin	**Willimantic**
Regional Basin No.	**31**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**219**

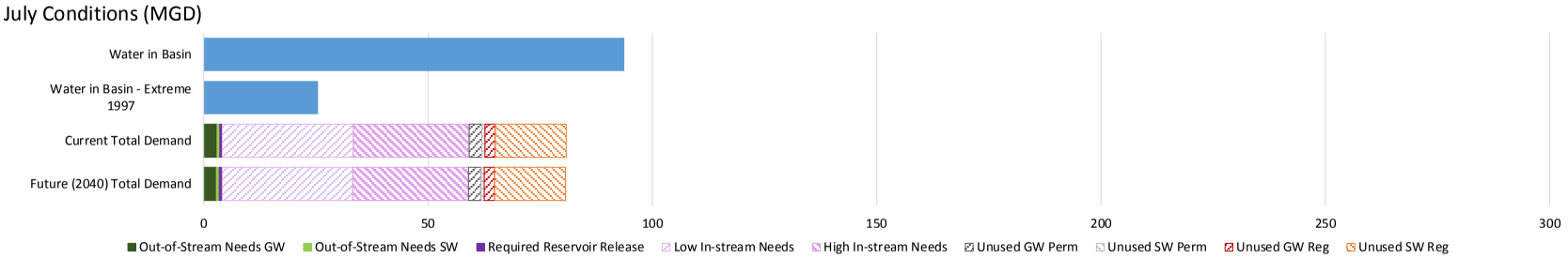
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	48.7	508	Water In
Wastewater Discharge	0.3	3.3	
Estimated Domestic Recharge	0.3	2.6	
Evapotranspiration	22.5	235	Water Out
Groundwater Withdrawals	0.5	4.9	
Surface Water Withdrawals	0.0	0.5	
Stormflow	12.4	129	Internal
Estimated Potential Recharge (EPR)	13.2	137	
Total Streamflow (Stormflow + EPR)	25.5	266	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	266	2.22	0.49	0.56	184.7		2.85	2.38	0.68	15.86
Future (2040) Conditions, ADD		1.92	0.51	0.61	184.7		2.85	2.38	0.68	15.84
Current Conditions, MMADD	94	2.99	0.60	0.56	29.8	55.6	2.84	2.32	0.68	15.80
Future (2040) Conditions, MMADD		2.83	0.61	0.72	29.8	55.6	2.84	2.32	0.68	15.78

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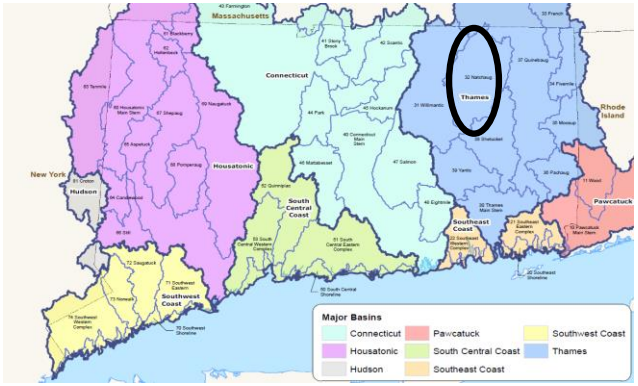
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Basin Water Summary

Regional Basin	**Natchaug**
Regional Basin No.	**32**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**175**

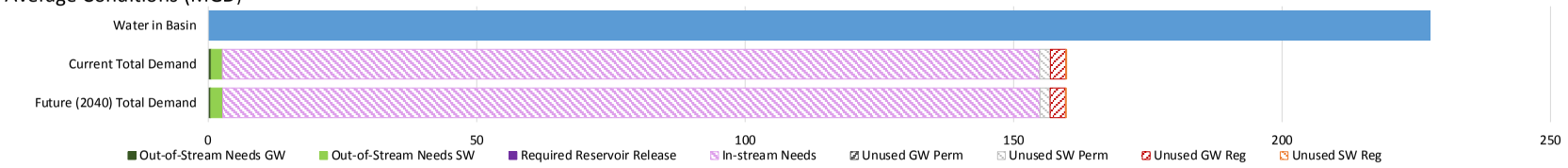
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.2	411	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.1	1.0	
Evapotranspiration	22.4	187	Water Out
Groundwater Withdrawals	0.2	1.5	
Surface Water Withdrawals	0.3	2.1	
Stormflow	13.9	116	Internal
Estimated Potential Recharge (EPR)	13.4	112	
Total Streamflow (Stormflow + EPR)	27.3	228	

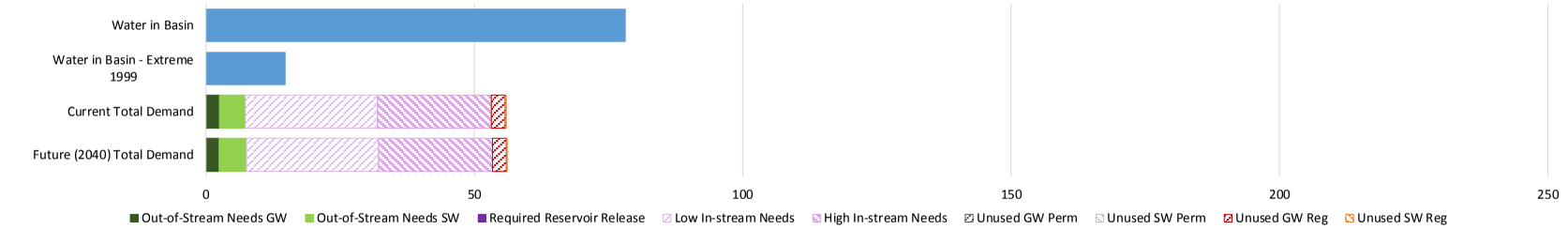


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	228	0.53	2.10	NA	152.2		0.00	2.84	2.00	0.17
Future (2040) Conditions, ADD		0.47	2.21	0.00	152.2		0.00	2.84	1.89	0.17
Current Conditions, MMADD	78	2.52	4.83	NA	24.6	45.8	0.00	2.60	-0.73	0.17
Future (2040) Conditions, MMADD		2.47	5.09	0.00	24.6	45.8	0.00	2.60	-0.99	0.17

Notes:

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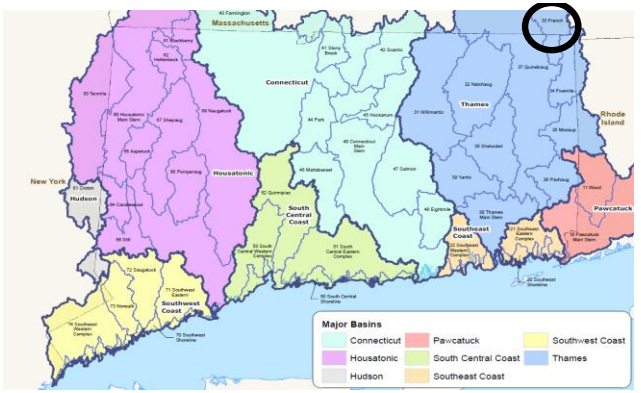
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Basin Water Summary

Regional Basin	**French**
Regional Basin No.	**33**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**17**

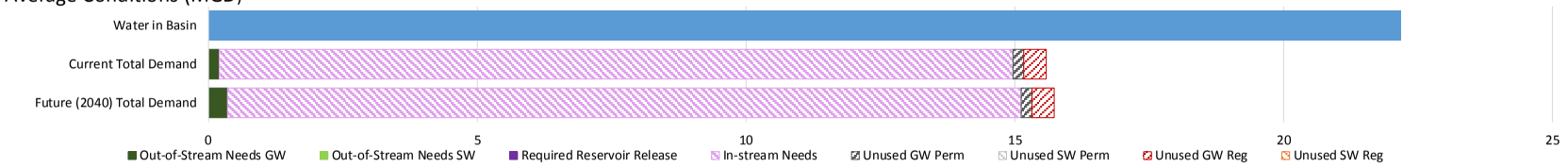
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	45.3	37	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.2	0.1	
Evapotranspiration	22.0	18	Water Out
Groundwater Withdrawals	0.4	0.3	
Surface Water Withdrawals	0.0	0.0	
Stormflow	13.0	11	Internal
Estimated Potential Recharge (EPR)	14.2	12	
Total Streamflow (Stormflow + EPR)	27.3	22	

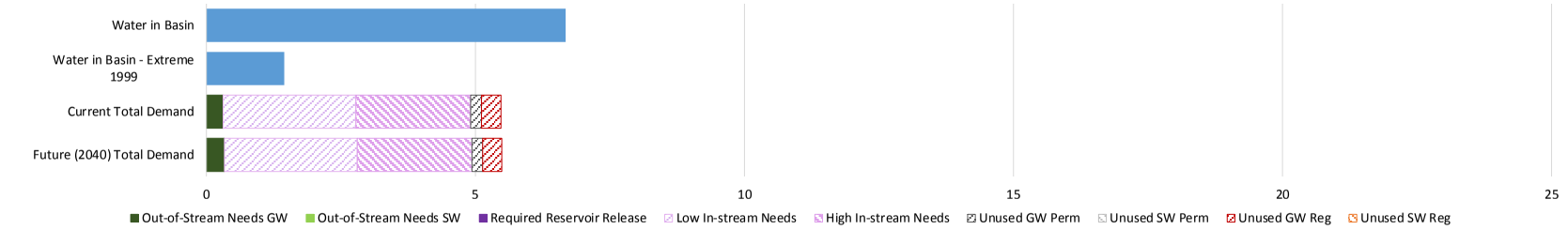


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	22	0.20	0.00	NA	14.8		0.20	0.42	0.00	0.00
Future (2040) Conditions, ADD		0.35	0.00	0.00	14.8		0.20	0.41	0.00	0.00
Current Conditions, MMADD	7	0.31	0.00	NA	2.5	4.6	0.20	0.36	0.00	0.00
Future (2040) Conditions, MMADD		0.34	0.00	0.00	2.5	4.6	0.20	0.35	0.00	0.00

Notes:

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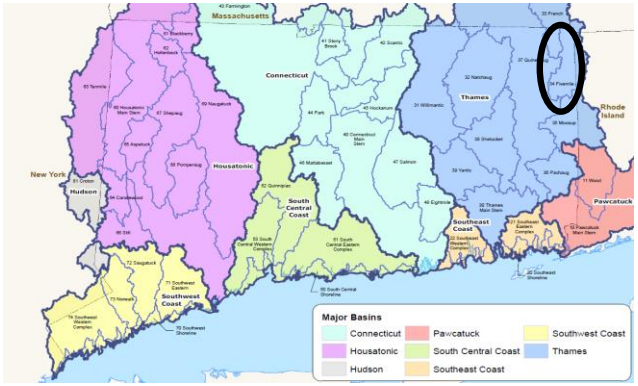
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Basin Water Summary

Regional Basin	**Fivemile**
Regional Basin No.	**34**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**52**

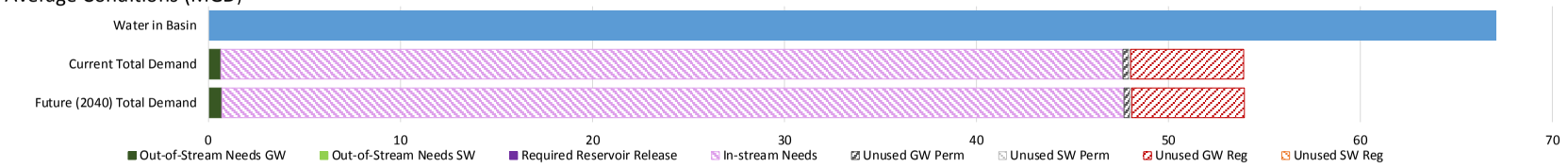
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.8	116	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.2	0.4	
Evapotranspiration	22.3	55	Water Out
Groundwater Withdrawals	0.4	1.0	
Surface Water Withdrawals	0.0	0.0	
Stormflow	13.2	33	Internal
Estimated Potential Recharge (EPR)	13.9	34	
Total Streamflow (Stormflow + EPR)	27.1	67	

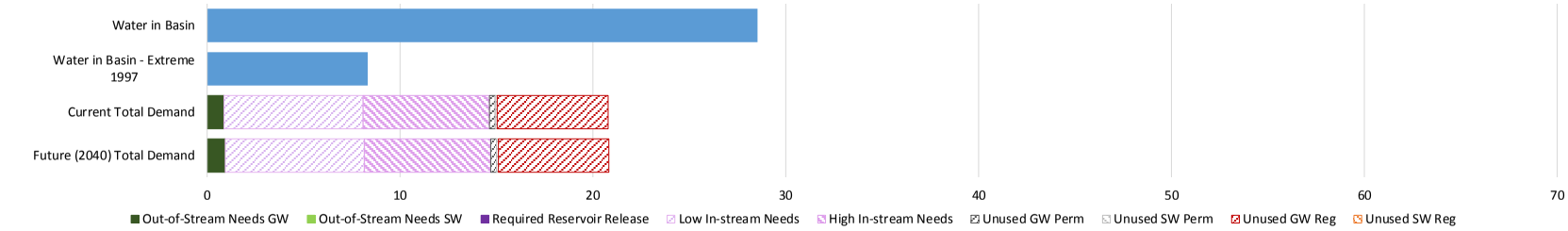


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	67	0.64	0.00	NA	47.0		0.30	5.88	0.10	0.00
Future (2040) Conditions, ADD		0.69	0.00	0.00	47.0		0.30	5.87	0.10	0.00
Current Conditions, MMADD	29	0.88	0.00	NA	7.2	13.8	0.30	5.75	0.10	0.00
Future (2040) Conditions, MMADD		0.94	0.00	0.00	7.2	13.8	0.30	5.73	0.10	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
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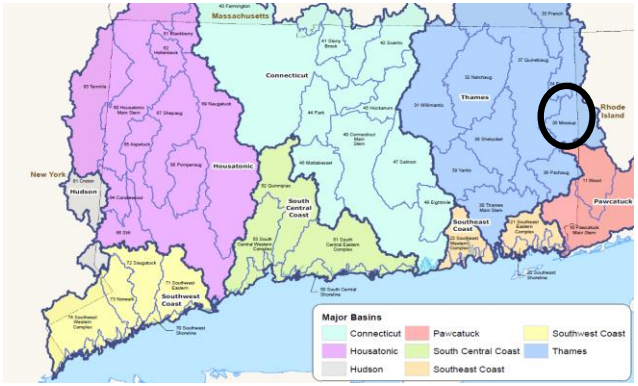
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Moosup**
Regional Basin No.	**35**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**49**

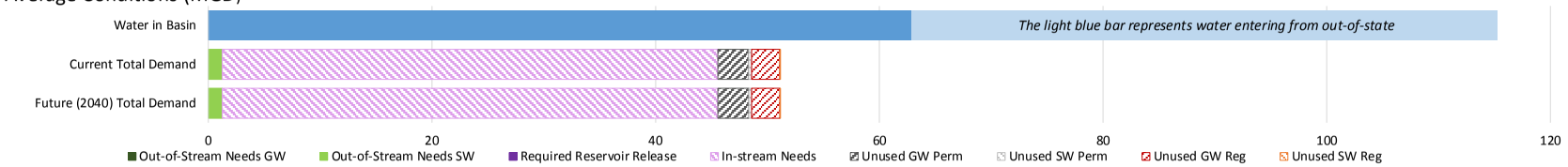
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.0	113	Water In
Wastewater Discharge	0.3	0.7	
Estimated Domestic Recharge	0.2	0.4	
Evapotranspiration	22.5	52	Water Out
Groundwater Withdrawals	2.6	6.1	
Surface Water Withdrawals	0.5	1.2	
Stormflow	12.0	28	Internal
Estimated Potential Recharge (EPR)	15.2	35	
Total Streamflow (Stormflow + EPR)	27.2	63	

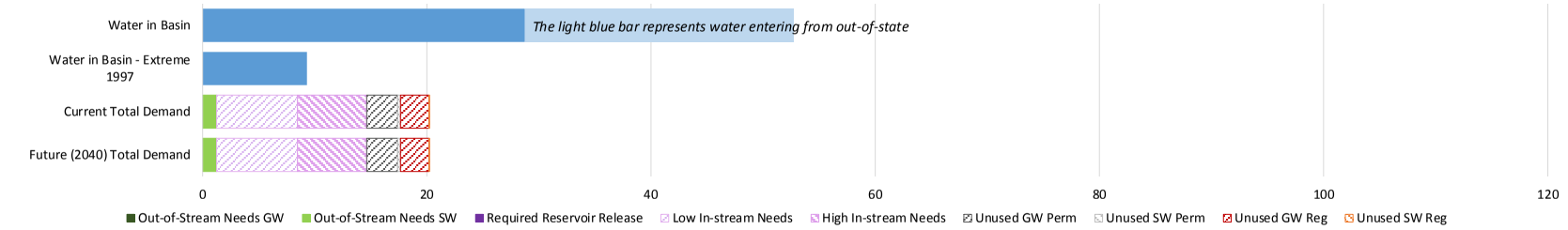


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Water Flowing from RI	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	63	52	5.70	1.25	NA	44.3		2.77	2.52	0.25	0.06
Future (2040) Conditions, ADD			5.71	1.25	0.00	44.3		2.77	2.52	0.25	0.06
Current Conditions, MMADD	29	24	5.71	1.25	NA	7.2	13.4	2.77	2.52	0.25	0.06
Future (2040) Conditions, MMADD			5.71	1.25	0.00	7.2	13.4	2.77	2.52	0.25	0.06

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

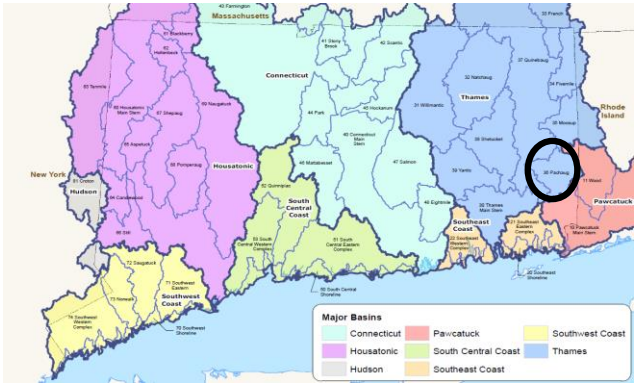
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Pachaug**
Regional Basin No.	**36**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**62**

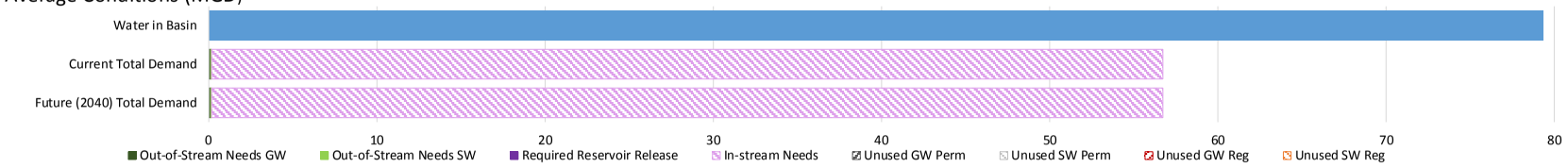
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	50.3	148	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.1	0.4	
Evapotranspiration	22.7	66	Water Out
Groundwater Withdrawals	0.2	0.5	
Surface Water Withdrawals	0.0	0.0	
Stormflow	10.9	32	Internal
Estimated Potential Recharge (EPR)	16.2	47	
Total Streamflow (Stormflow + EPR)	27.1	79	

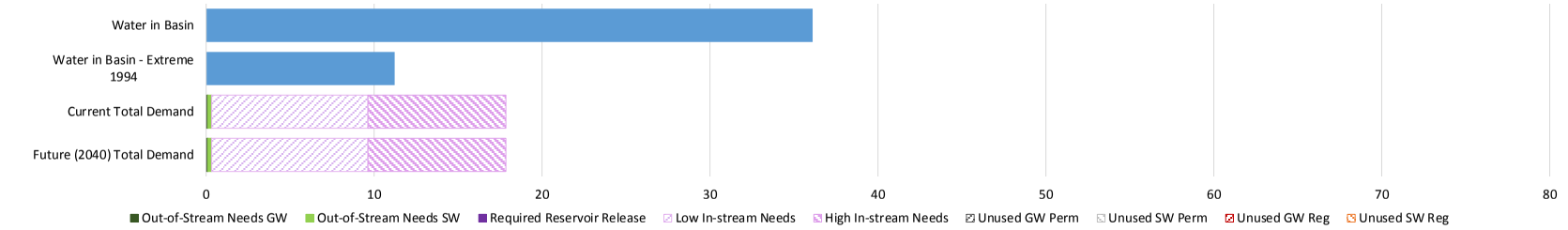


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	79	0.11	0.05	NA	56.6		0.00	0.00	0.00	0.00
Future (2040) Conditions, ADD		0.11	0.05	0.00	56.6		0.00	0.00	0.00	0.00
Current Conditions, MMADD	36	0.11	0.22	NA	9.3	17.5	0.00	0.00	0.00	0.00
Future (2040) Conditions, MMADD		0.11	0.22	0.00	9.3	17.5	0.00	0.00	0.00	0.00

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
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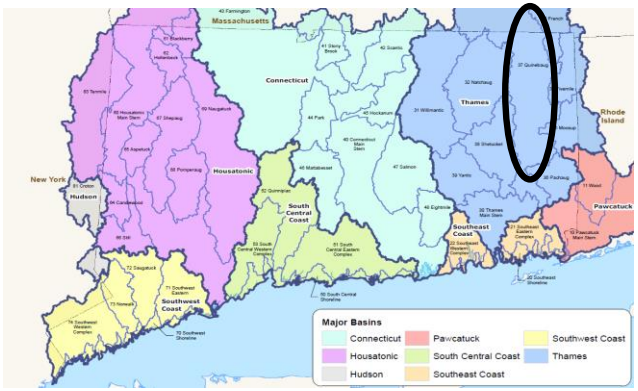
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Basin Water Summary

Regional Basin	**Quinebaug**
Regional Basin No.	**37**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**256**

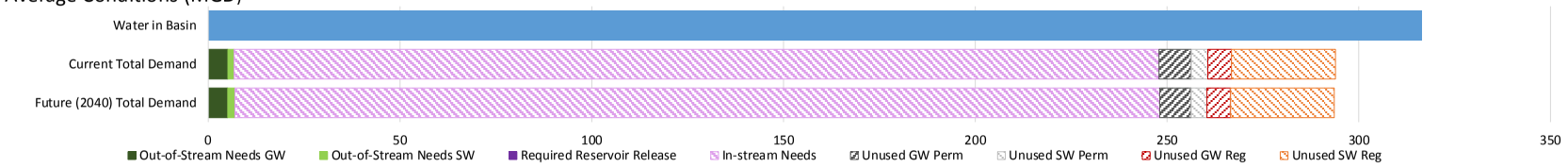
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	48.4	591	Water In
Wastewater Discharge	0.4	5.3	
Estimated Domestic Recharge	0.1	1.8	
Evapotranspiration	22.3	272	Water Out
Groundwater Withdrawals	0.6	6.9	
Surface Water Withdrawals	0.1	1.6	
Stormflow	13.1	160	Internal
Estimated Potential Recharge (EPR)	12.9	157	
Total Streamflow (Stormflow + EPR)	25.9	316	

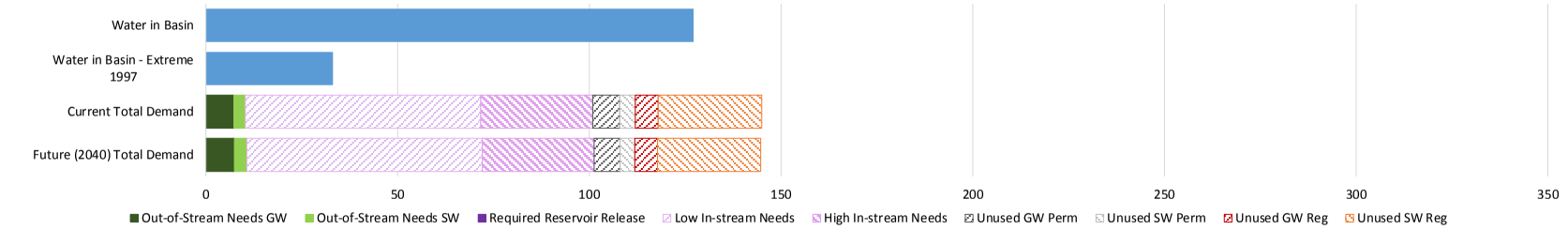


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	316	5.10	1.63	NA	241.2		8.44	6.19	4.29	27.10
Future (2040) Conditions, ADD		5.09	1.83	0.00	241.2		8.21	6.15	4.13	27.03
Current Conditions, MMADD	127	7.32	2.99	NA	61.4	90.6	7.07	5.97	4.03	26.98
Future (2040) Conditions, MMADD		7.43	3.24	0.00	61.4	90.6	6.75	5.92	3.84	26.89

Notes:

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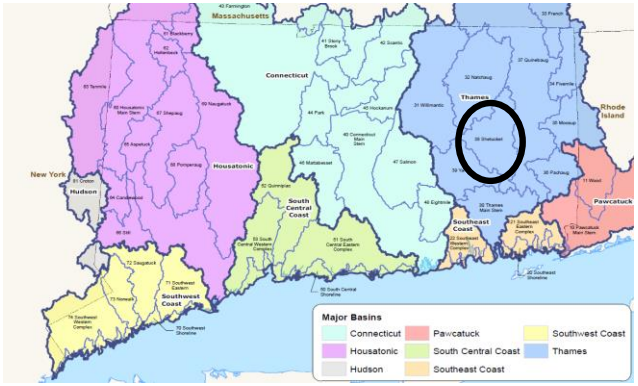
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Basin Water Summary

Regional Basin	**Shetucket**
Regional Basin No.	**38**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**125**

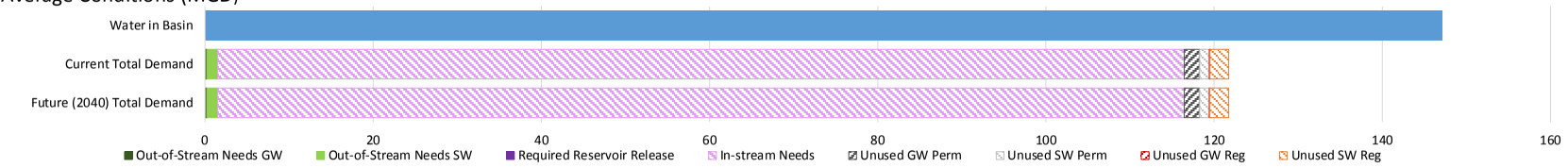
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.4	294	Water In
Wastewater Discharge	0.0	0.1	
Estimated Domestic Recharge	0.2	1.0	
Evapotranspiration	22.6	135	Water Out
Groundwater Withdrawals	0.2	1.2	
Surface Water Withdrawals	0.2	1.3	
Stormflow	12.2	72	Internal
Estimated Potential Recharge (EPR)	12.6	75	
Total Streamflow (Stormflow + EPR)	24.7	147	

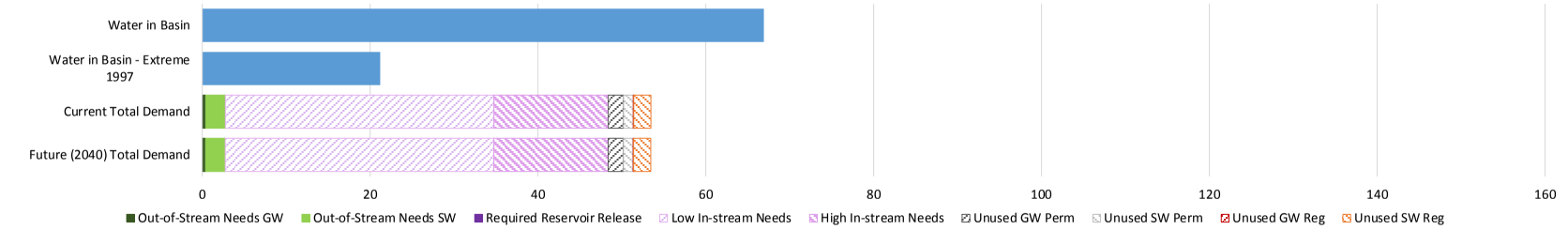


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	147	0.20	1.32	NA	114.9		1.84	0.06	1.15	2.23
Future (2040) Conditions, ADD		0.20	1.31	0.00	114.9		1.84	0.06	1.15	2.24
Current Conditions, MMADD	67	0.40	2.35	NA	32.0	45.6	1.83	0.05	1.15	2.05
Future (2040) Conditions, MMADD		0.40	2.34	0.00	32.0	45.6	1.83	0.05	1.15	2.06

Notes:

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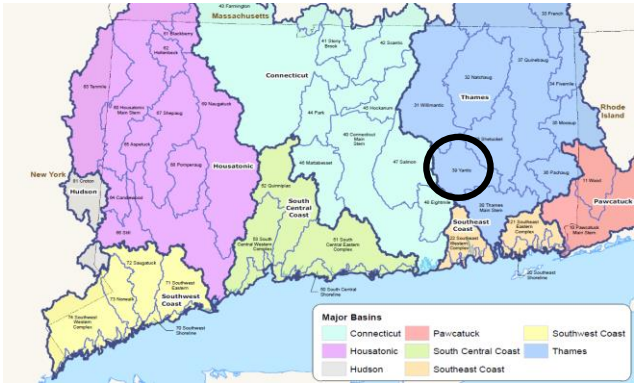
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Basin Water Summary

Regional Basin	**Yantic**
Regional Basin No.	**39**
Major Basin	**Thames**
Size of Basin in CT (mi^2)	**98**

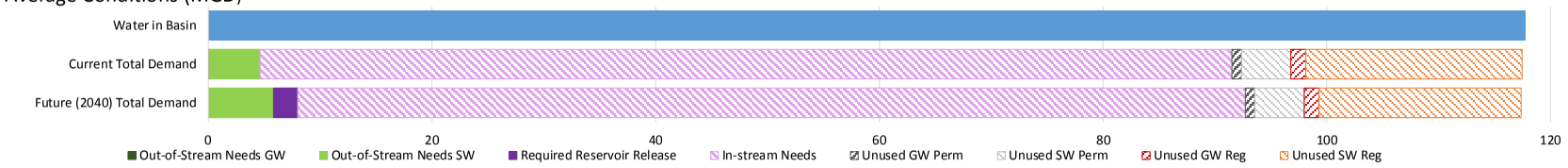
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	48.8	227	Water In
Wastewater Discharge	0.7	3.4	
Estimated Domestic Recharge	0.2	0.7	
Evapotranspiration	22.7	106	Water Out
Groundwater Withdrawals	0.2	0.8	
Surface Water Withdrawals	1.0	4.5	
Stormflow	12.4	58	Internal
Estimated Potential Recharge (EPR)	12.9	60	
Total Streamflow (Stormflow + EPR)	25.3	118	

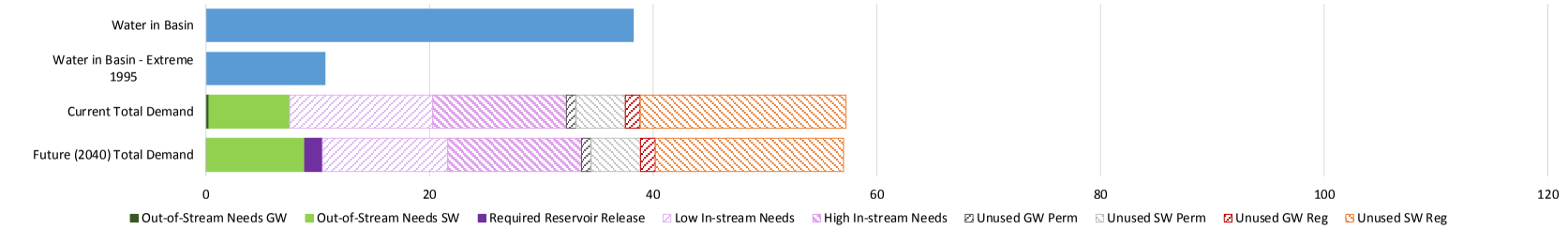


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	118	0.09	4.54	NA	86.9		0.86	1.33	4.40	19.34
Future (2040) Conditions, ADD		-0.14	5.82	2.17	86.9		0.86	1.33	4.40	18.06
Current Conditions, MMADD	38	0.27	7.22	NA	12.8	24.8	0.86	1.33	4.40	18.41
Future (2040) Conditions, MMADD		0.05	8.79	1.58	12.8	24.8	0.86	1.33	4.40	16.83

Notes:

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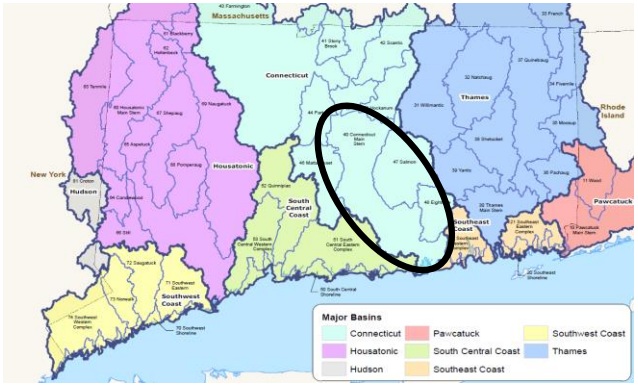
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Basin Water Summary

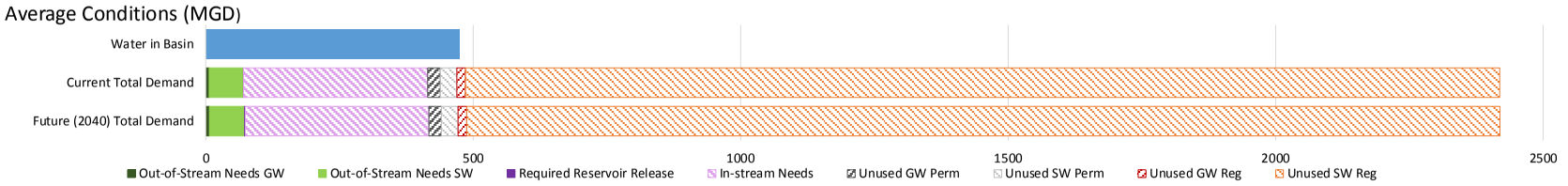
Regional Basin	**Connecticut Main Stem**
Regional Basin No.	**40**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**387**

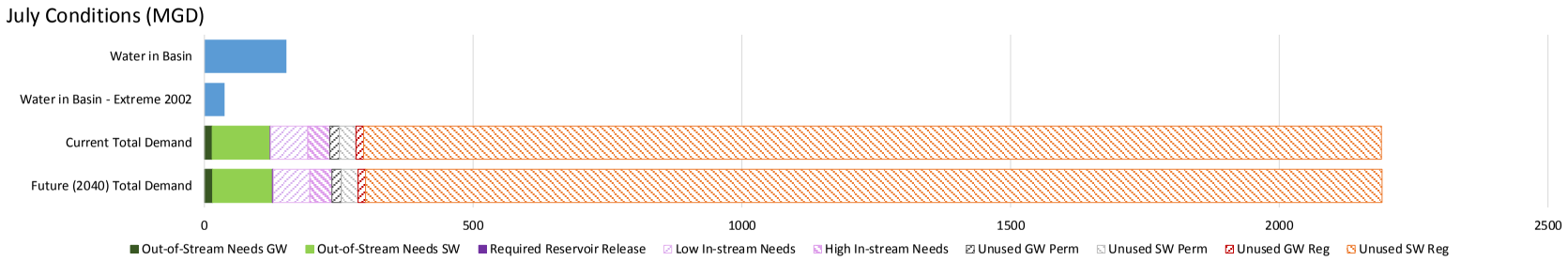
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.0	866	Water In
Wastewater Discharge	16.6	305.0	
Estimated Domestic Recharge	0.3	5.7	
Evapotranspiration	22.7	418	Water Out
Groundwater Withdrawals	0.7	12.1	
Surface Water Withdrawals	3.5	64.0	
Stormflow	12.9	238	Internal
Estimated Potential Recharge (EPR)	12.9	237	
Total Streamflow (Stormflow + EPR)	25.8	475	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	475	6.40	63.99	0.36	344.6		23.58	16.25	30.93	1933.04
Future (2040) Conditions, ADD		6.87	65.80	1.48	344.6		23.50	16.22	30.93	1931.31
Current Conditions, MMADD	153	14.54	108.07	0.36	69.7	110.7	17.86	14.17	30.93	1894.06
Future (2040) Conditions, MMADD		15.49	111.10	1.37	69.7	110.7	17.72	14.12	30.93	1891.25

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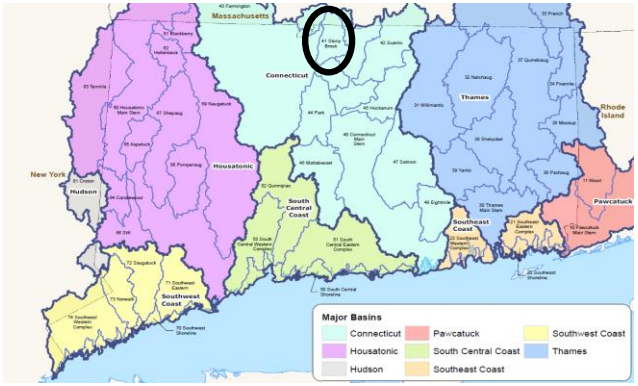
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Stony Brook**
Regional Basin No.	**41**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**36**

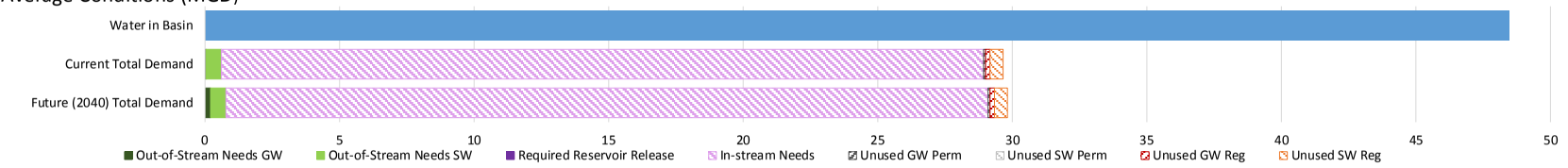
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.0	80	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.2	0.4	
Evapotranspiration	22.3	38	Water Out
Groundwater Withdrawals	0.3	0.5	
Surface Water Withdrawals	0.3	0.6	
Stormflow	14.4	24	Internal
Estimated Potential Recharge (EPR)	14.1	24	
Total Streamflow (Stormflow + EPR)	28.5	48	

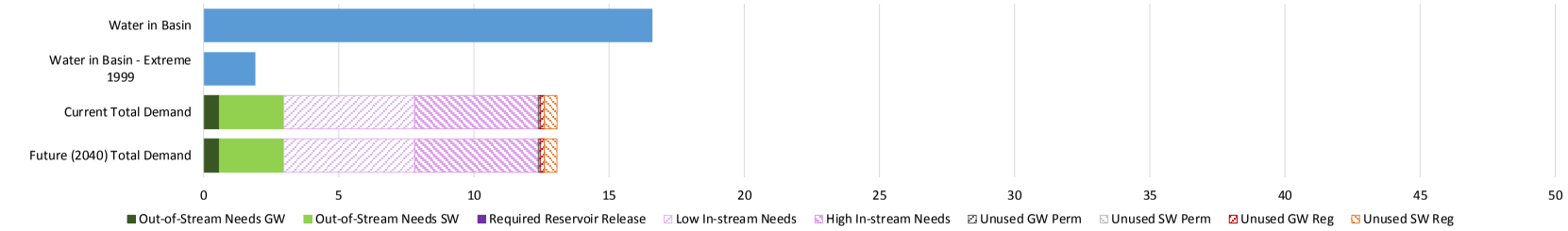


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	48	0.04	0.57	NA	28.3		0.08	0.16	0.00	0.48
Future (2040) Conditions, ADD		0.21	0.57	0.00	28.3		0.08	0.16	0.00	0.48
Current Conditions, MMADD	17	0.58	2.38	NA	4.8	9.4	0.07	0.16	0.00	0.47
Future (2040) Conditions, MMADD		0.58	2.38	0.00	4.8	9.4	0.07	0.16	0.00	0.47

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

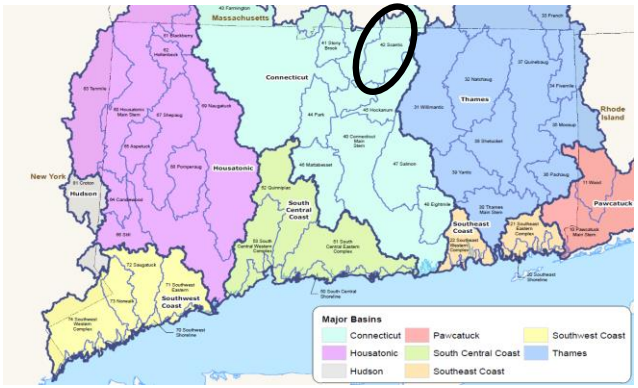
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Scantic**
Regional Basin No.	**42**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**83**

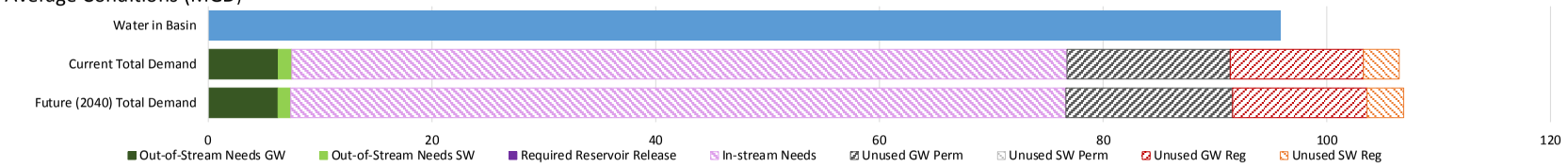
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.9	189	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.3	1.3	
Evapotranspiration	22.4	89	Water Out
Groundwater Withdrawals	1.9	7.5	
Surface Water Withdrawals	0.3	1.2	
Stormflow	11.2	45	Internal
Estimated Potential Recharge (EPR)	13.0	51	
Total Streamflow (Stormflow + EPR)	24.2	96	

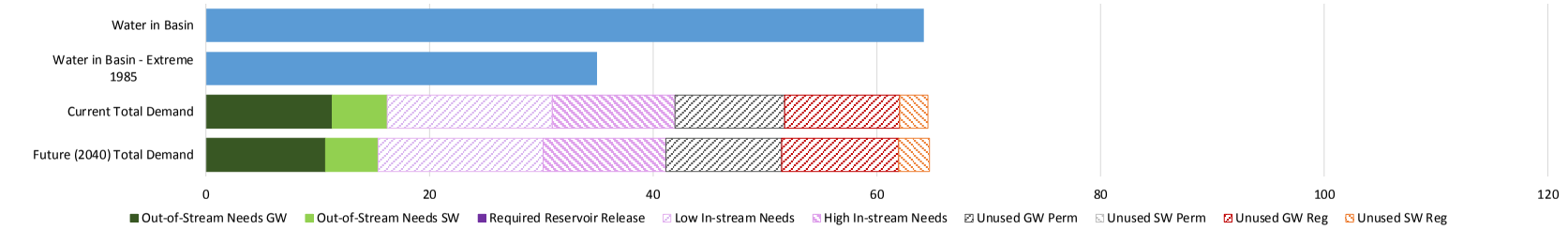


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	96	6.26	1.21	NA	69.3		14.59	11.91	0.00	3.20
Future (2040) Conditions, ADD		6.23	1.13	0.00	69.3		14.90	12.02	0.00	3.28
Current Conditions, MMADD	64	11.30	4.92	NA	14.8	25.7	9.80	10.29	0.00	2.52
Future (2040) Conditions, MMADD		10.70	4.70	0.00	14.8	25.7	10.35	10.47	0.00	2.74

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

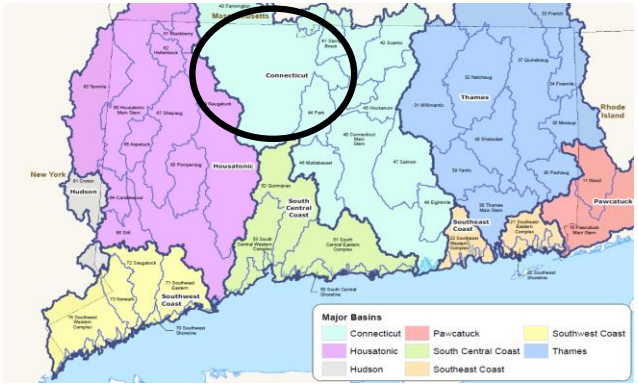
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Basin Water Summary

Regional Basin	**Farmington**
Regional Basin No.	**43**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**451**

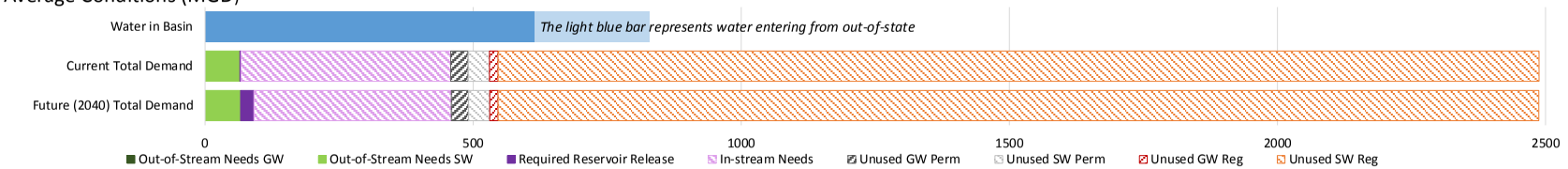
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.7	1002	Water In
Wastewater Discharge	0.8	17.0	
Estimated Domestic Recharge	0.2	5.3	
Evapotranspiration	21.5	463	Water Out
Groundwater Withdrawals	0.7	15.3	
Surface Water Withdrawals	3.0	65.0	
Stormflow	14.7	316	Internal
Estimated Potential Recharge (EPR)	14.0	300	
Total Streamflow (Stormflow + EPR)	28.7	615	

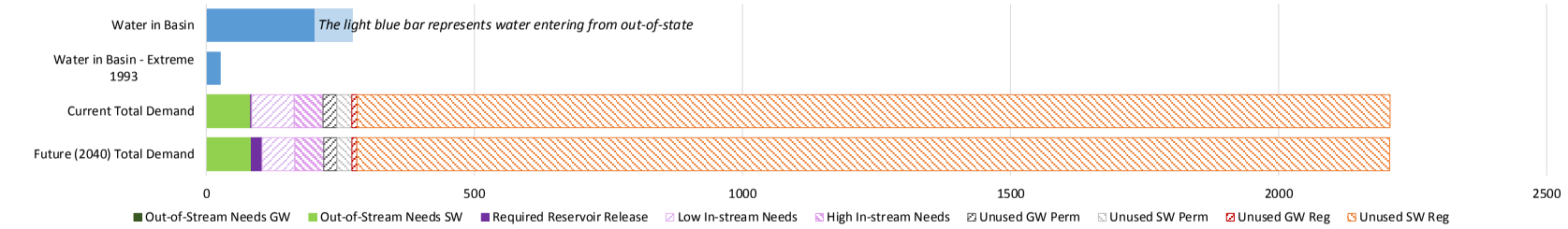


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Water Flowing from MA	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	615	213	10.00	64.98	1.97	393.2		32.63	16.16	39.55	1941.27
Future (2040) Conditions, ADD			10.27	66.17	24.97	393.2		32.06	15.67	39.36	1941.02
Current Conditions, MMADD	203	70	18.42	82.84	1.97	81.1	134.9	25.63	10.17	27.97	1926.45
Future (2040) Conditions, MMADD			18.99	84.22	19.73	81.1	134.9	24.71	9.38	27.73	1926.15

Notes:

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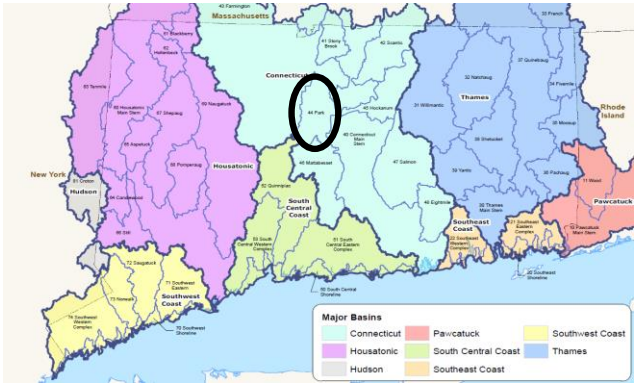
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Basin Water Summary

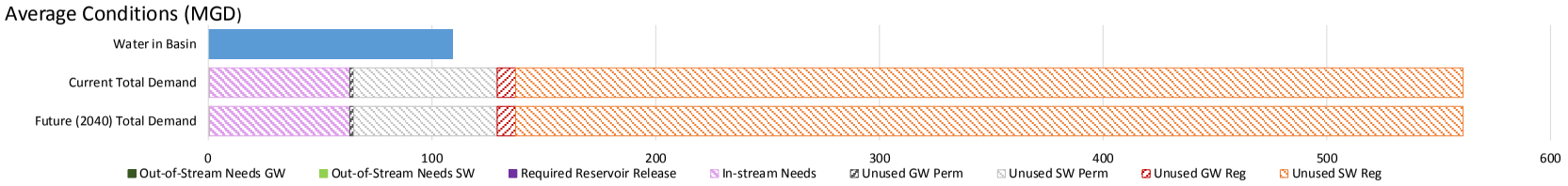
Regional Basin	**Park**
Regional Basin No.	**44**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**77**

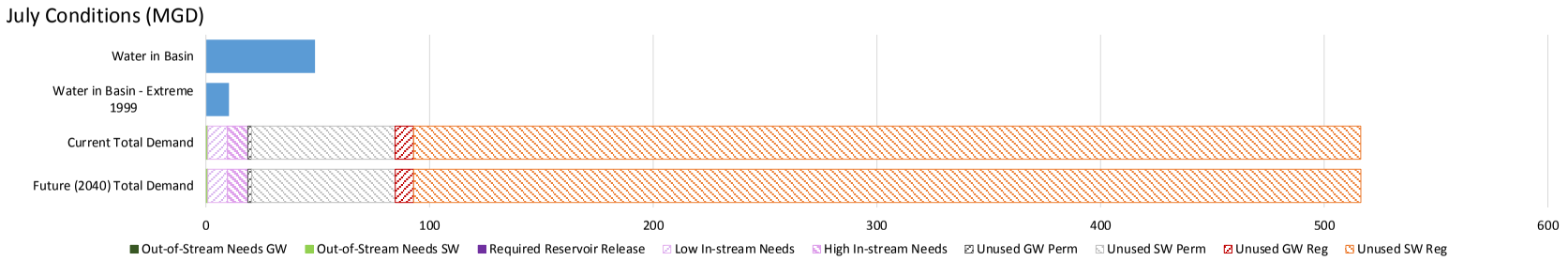
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.4	171	Water In
Wastewater Discharge	3.8	13.9	
Estimated Domestic Recharge	0.4	1.5	
Evapotranspiration	22.5	83	Water Out
Groundwater Withdrawals	0.1	0.2	
Surface Water Withdrawals	0.1	0.5	
Stormflow	15.8	58	Internal
Estimated Potential Recharge (EPR)	13.9	51	
Total Streamflow (Stormflow + EPR)	29.7	109	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	109	-1.25	0.53	NA	62.7		1.76	8.24	64.15	423.56
Future (2040) Conditions, ADD		-1.28	0.54	0.00	62.7		1.76	8.24	64.15	423.55
Current Conditions, MMADD	49	-1.13	0.89	NA	8.7	17.8	1.76	8.22	64.15	423.51
Future (2040) Conditions, MMADD		-1.15	0.90	0.00	8.7	17.8	1.76	8.22	64.15	423.50

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

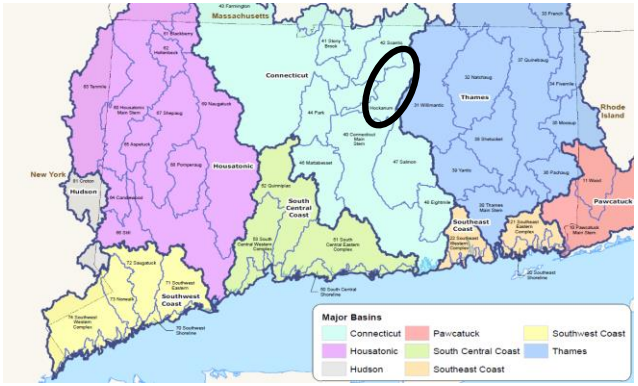
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Basin Water Summary

Regional Basin	**Hockanum**
Regional Basin No.	**45**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**77**

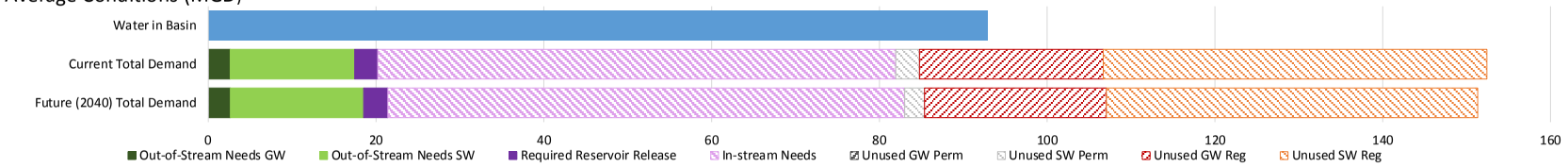
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.9	176	Water In
Wastewater Discharge	4.6	16.8	
Estimated Domestic Recharge	0.4	1.6	
Evapotranspiration	22.6	83	Water Out
Groundwater Withdrawals	1.2	4.3	
Surface Water Withdrawals	4.0	14.8	
Stormflow	12.0	44	Internal
Estimated Potential Recharge (EPR)	13.2	49	
Total Streamflow (Stormflow + EPR)	25.3	93	

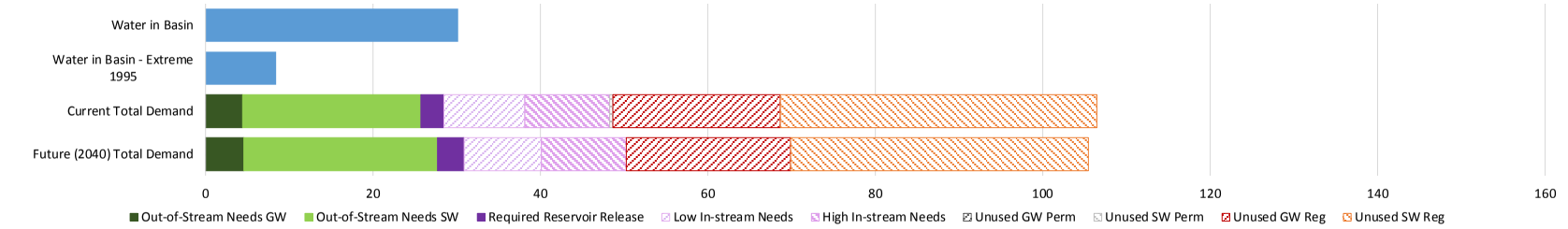


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	93	2.61	14.85	2.74	64.5		-0.67	21.91	2.83	45.73
Future (2040) Conditions, ADD		2.64	15.88	2.89	64.5		-0.84	21.68	2.37	44.26
Current Conditions, MMADD	30	4.42	21.31	2.74	12.4	22.6	-2.01	20.00	0.37	37.81
Future (2040) Conditions, MMADD		4.59	23.12	3.19	12.4	22.6	-2.27	19.64	-0.33	35.56

Notes:

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3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
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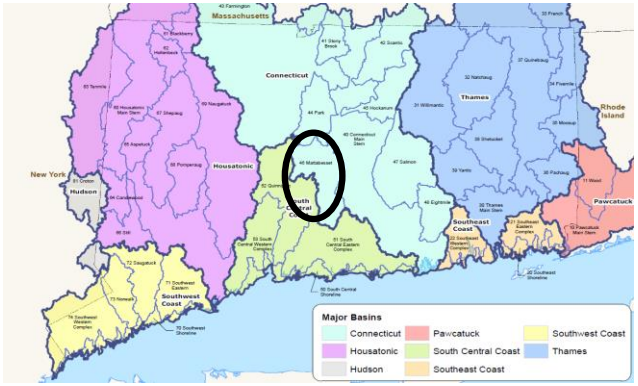
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Basin Water Summary

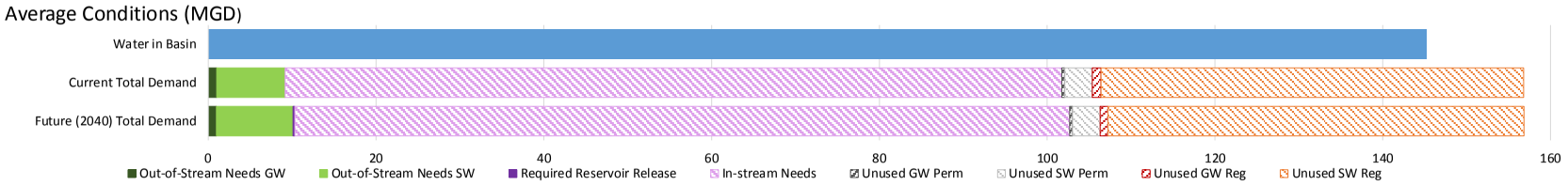
Regional Basin	**Mattabesset**
Regional Basin No.	**46**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**109**

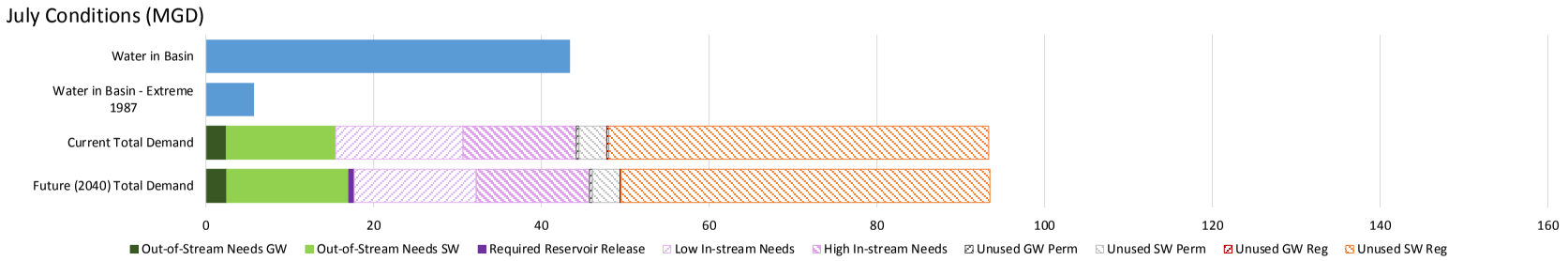
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	45.3	235	Water In
Wastewater Discharge	3.0	15.6	
Estimated Domestic Recharge	0.4	2.1	
Evapotranspiration	22.7	118	Water Out
Groundwater Withdrawals	0.6	3.1	
Surface Water Withdrawals	1.6	8.2	
Stormflow	14.1	73	Internal
Estimated Potential Recharge (EPR)	13.9	72	
Total Streamflow (Stormflow + EPR)	28.0	145	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	145	0.99	8.17	NA	92.6		0.35	1.03	3.28	50.38
Future (2040) Conditions, ADD		0.97	9.12	0.22	92.6		0.35	0.95	3.28	49.58
Current Conditions, MMADD	43	2.42	13.04	NA	15.2	28.7	0.35	0.25	3.28	45.29
Future (2040) Conditions, MMADD		2.48	14.56	0.65	15.2	28.7	0.35	0.13	3.28	43.99

Notes:

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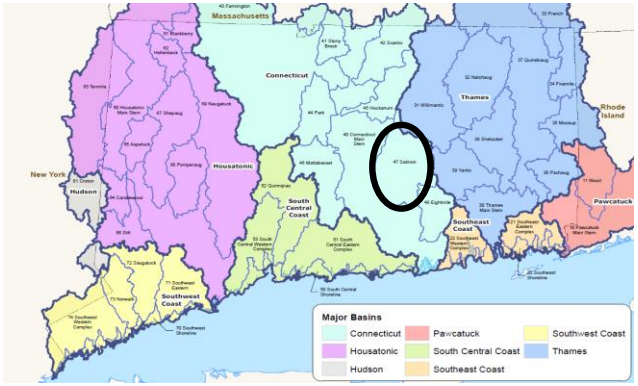
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Basin Water Summary

Regional Basin	**Salmon**
Regional Basin No.	**47**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**149**

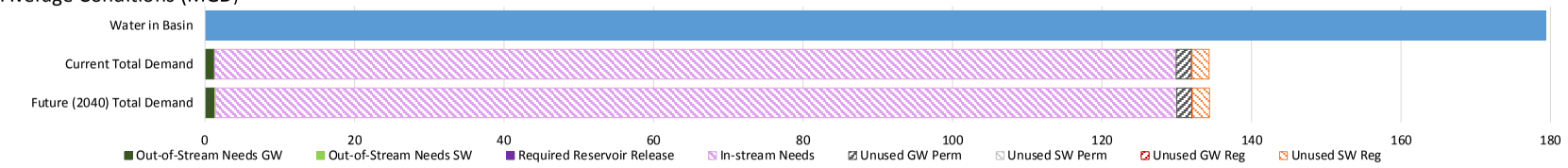
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.8	339	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.3	1.8	
Evapotranspiration	22.8	161	Water Out
Groundwater Withdrawals	0.4	3.0	
Surface Water Withdrawals	0.0	0.1	
Stormflow	12.1	86	Internal
Estimated Potential Recharge (EPR)	13.2	94	
Total Streamflow (Stormflow + EPR)	25.3	179	

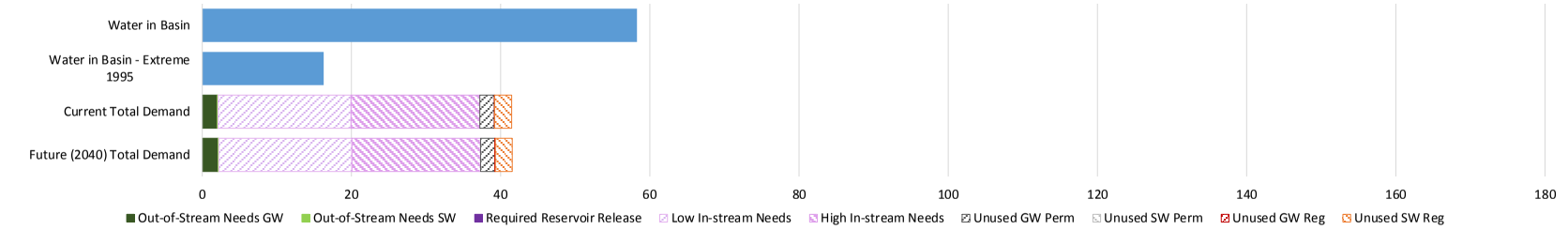


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	179	1.25	0.07	NA	128.6		2.05	0.06	0.00	2.29
Future (2040) Conditions, ADD		1.31	0.07	0.00	128.6		2.03	0.06	0.00	2.29
Current Conditions, MMADD	58	2.02	0.09	NA	17.8	35.1	1.95	0.06	0.00	2.27
Future (2040) Conditions, MMADD		2.12	0.09	0.00	17.8	35.1	1.92	0.06	0.00	2.27

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
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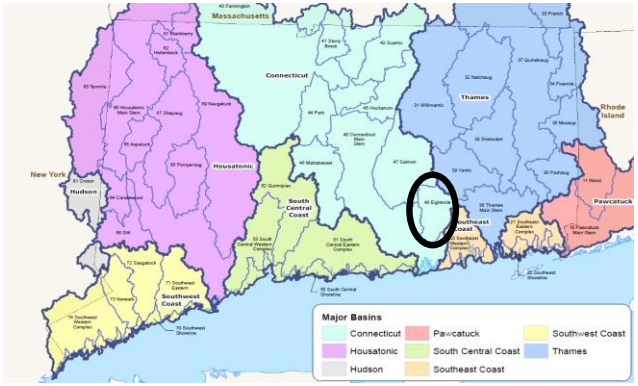
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Eightmile**
Regional Basin No.	**48**
Major Basin	**Connecticut**
Size of Basin in CT (mi^2)	**62**

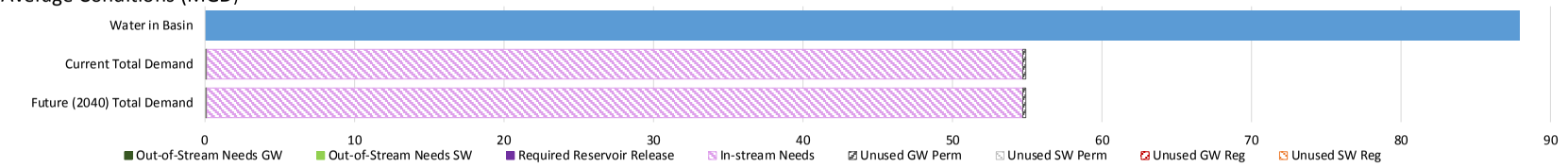
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.8	142	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.1	0.2	
Evapotranspiration	22.8	68	Water Out
Groundwater Withdrawals	0.1	0.4	
Surface Water Withdrawals	0.0	0.0	
Stormflow	14.9	44	Internal
Estimated Potential Recharge (EPR)	14.7	44	
Total Streamflow (Stormflow + EPR)	29.6	88	

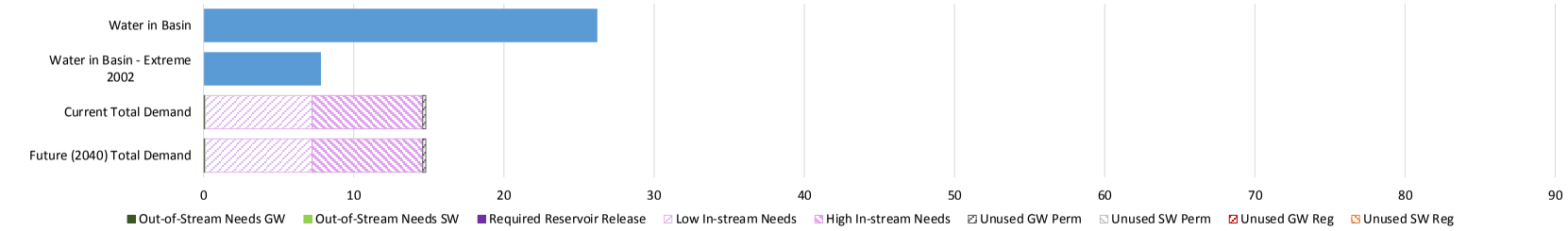


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	88	0.12	0.00	NA	54.6		0.20	0.00	0.00	0.00
Future (2040) Conditions, ADD		0.12	0.00	0.00	54.6		0.20	0.00	0.00	0.00
Current Conditions, MMADD	26	0.12	0.00	NA	7.1	14.5	0.20	0.00	0.00	0.00
Future (2040) Conditions, MMADD		0.12	0.00	0.00	7.1	14.5	0.20	0.00	0.00	0.00

Notes:

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4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

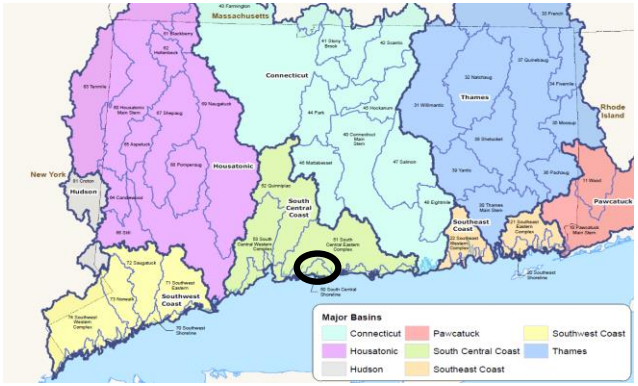
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Basin Water Summary

Regional Basin	**South Central Shoreline**
Regional Basin No.	**50**
Major Basin	**South Central Coast**
Size of Basin in CT (mi^2)	**59**

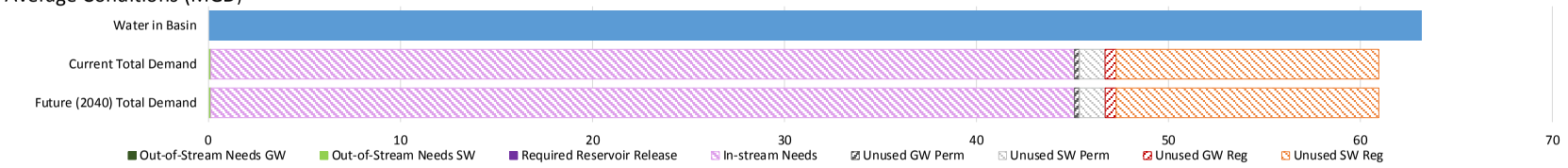
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	42.6	119	Water In
Wastewater Discharge	11.7	32.7	
Estimated Domestic Recharge	0.6	1.7	
Evapotranspiration	23.3	65	Water Out
Groundwater Withdrawals	0.1	0.2	
Surface Water Withdrawals	0.0	0.1	
Stormflow	11.9	33	Internal
Estimated Potential Recharge (EPR)	10.7	30	
Total Streamflow (Stormflow + EPR)	22.6	63	

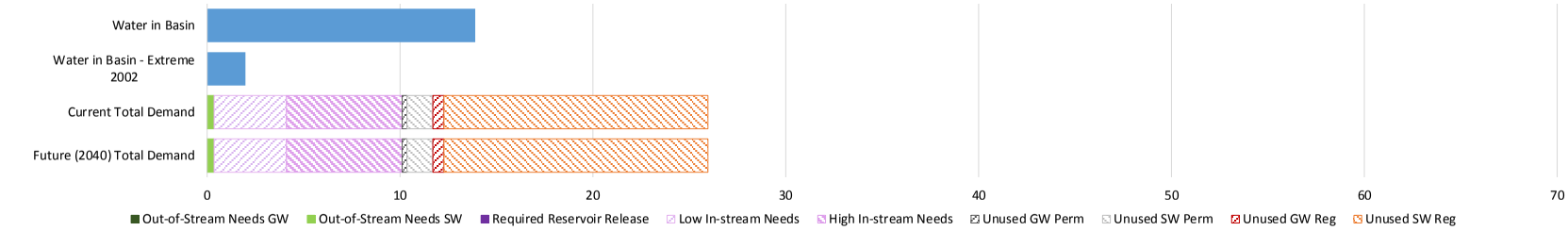


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	63	-1.52	0.13	NA	45.0		0.25	0.57	1.34	13.69
Future (2040) Conditions, ADD		-1.52	0.13	0.00	45.0		0.25	0.57	1.34	13.69
Current Conditions, MMADD	14	-1.52	0.36	NA	3.8	9.8	0.25	0.57	1.34	13.69
Future (2040) Conditions, MMADD		-1.52	0.36	0.00	3.8	9.8	0.25	0.57	1.34	13.69

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

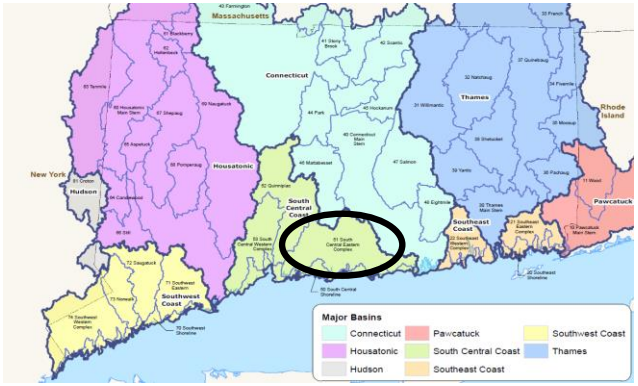
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

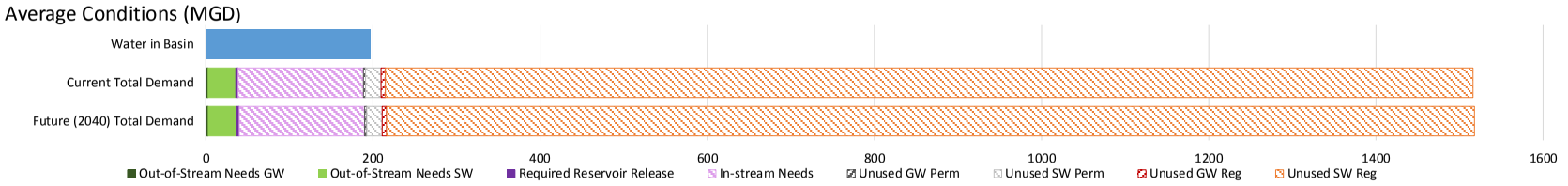
Regional Basin	**South Central Eastern**
Regional Basin No.	**51**
Major Basin	**South Central Coast**
Size of Basin in CT (mi^2)	**183**

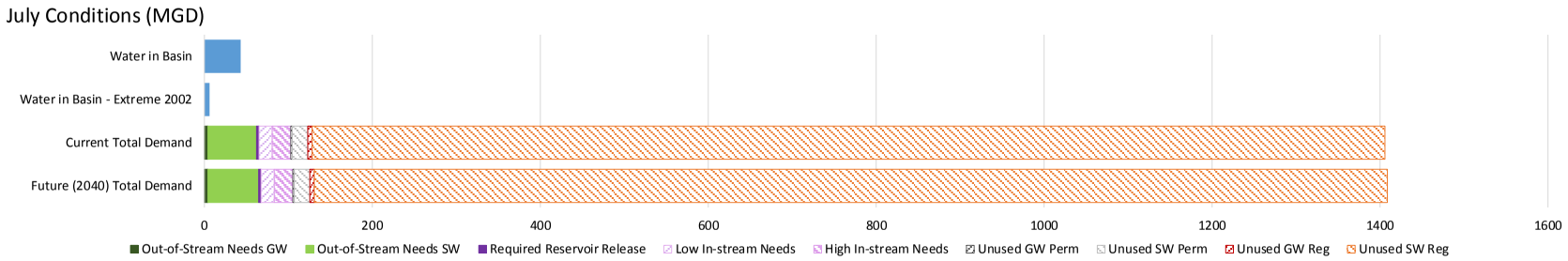
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	44.6	388	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.4	3.5	
Evapotranspiration	23.1	201	Water Out
Groundwater Withdrawals	0.7	6.5	
Surface Water Withdrawals	3.8	32.9	
Stormflow	11.7	102	Internal
Estimated Potential Recharge (EPR)	10.8	94	
Total Streamflow (Stormflow + EPR)	22.6	197	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	197	2.93	32.93	2.91	152.9		2.55	5.25	18.47	1301.17
Future (2040) Conditions, ADD		2.95	34.29	2.91	152.9		2.56	5.25	18.47	1301.44
Current Conditions, MMADD	43	4.31	57.84	2.91	18.7	40.6	1.96	5.25	18.47	1277.42
Future (2040) Conditions, MMADD		4.33	60.26	2.91	18.7	40.6	1.97	5.25	18.47	1277.89

Notes:

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3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

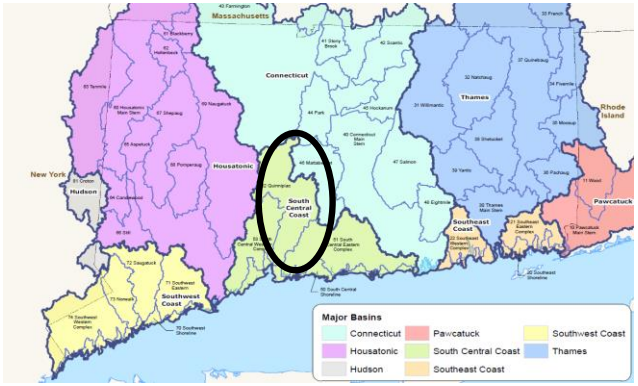
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Basin Water Summary

Regional Basin	**Quinnipiac**
Regional Basin No.	**52**
Major Basin	**South Central Coast**
Size of Basin in CT (mi^2)	**166**

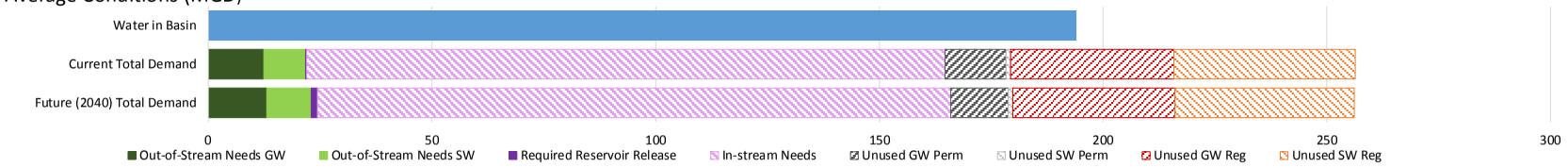
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	43.7	345	Water In
Wastewater Discharge	3.2	25.1	
Estimated Domestic Recharge	0.5	3.9	
Evapotranspiration	22.8	179	Water Out
Groundwater Withdrawals	2.1	16.3	
Surface Water Withdrawals	1.2	9.3	
Stormflow	12.4	98	Internal
Estimated Potential Recharge (EPR)	12.2	96	
Total Streamflow (Stormflow + EPR)	24.6	194	

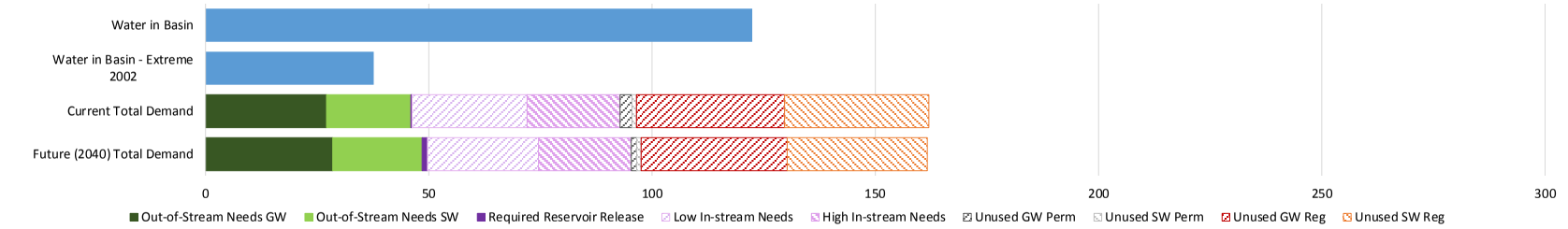


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	194	12.40	9.35	0.25	143.0		13.61	36.53	1.00	40.52
Future (2040) Conditions, ADD		13.06	9.95	1.40	143.0		12.85	36.30	1.00	40.03
Current Conditions, MMADD	122	27.10	18.88	0.25	26.0	46.9	2.66	33.18	1.00	32.31
Future (2040) Conditions, MMADD		28.50	20.01	1.19	26.0	46.9	1.19	32.73	1.00	31.37

Notes:

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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

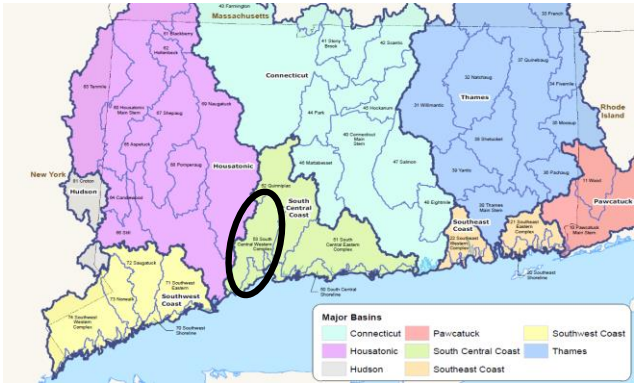
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Basin Water Summary

Regional Basin	**South Central Western**
Regional Basin No.	**53**
Major Basin	**South Central Coast**
Size of Basin in CT (mi^2)	**97**

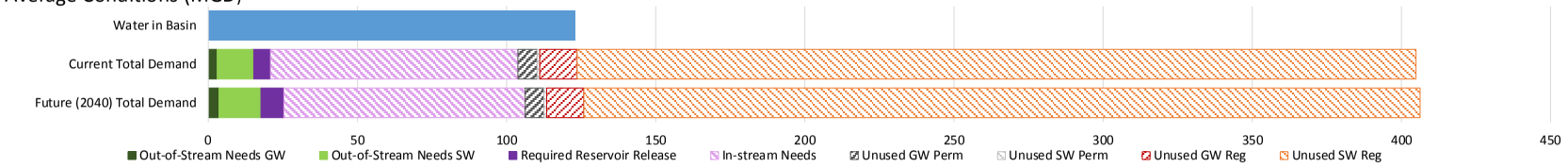
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	42.2	195	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.5	2.4	
Evapotranspiration	23.1	107	Water Out
Groundwater Withdrawals	1.2	5.3	
Surface Water Withdrawals	2.6	12.2	
Stormflow	13.7	64	Internal
Estimated Potential Recharge (EPR)	12.8	59	
Total Streamflow (Stormflow + EPR)	26.6	123	

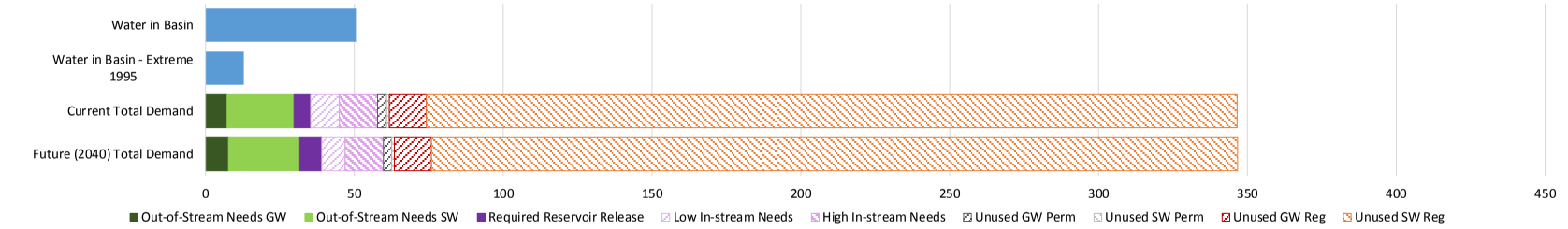


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	123	2.98	12.22	5.62	88.6		6.46	12.50	0.88	281.24
Future (2040) Conditions, ADD		3.56	14.09	7.66	88.6		6.29	12.49	0.88	280.35
Current Conditions, MMADD	51	7.26	22.43	5.62	15.3	28.1	3.06	12.47	0.88	272.33
Future (2040) Conditions, MMADD		7.70	23.93	7.42	15.3	28.1	2.78	12.47	0.88	270.84

Notes:

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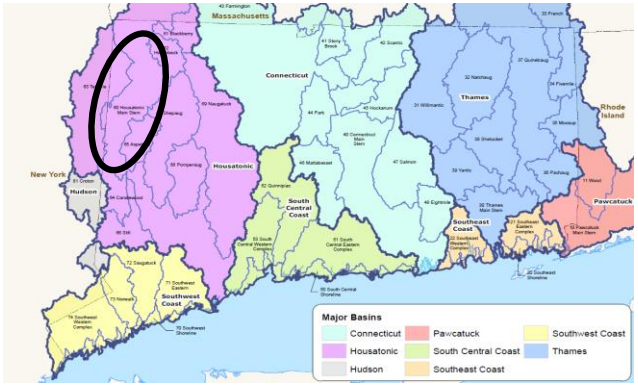
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Basin Water Summary

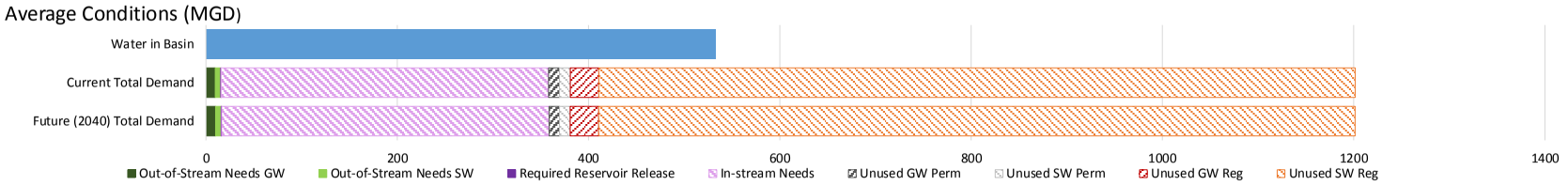
Regional Basin	**Housatonic Main Stem**
Regional Basin No.	**60**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**402**

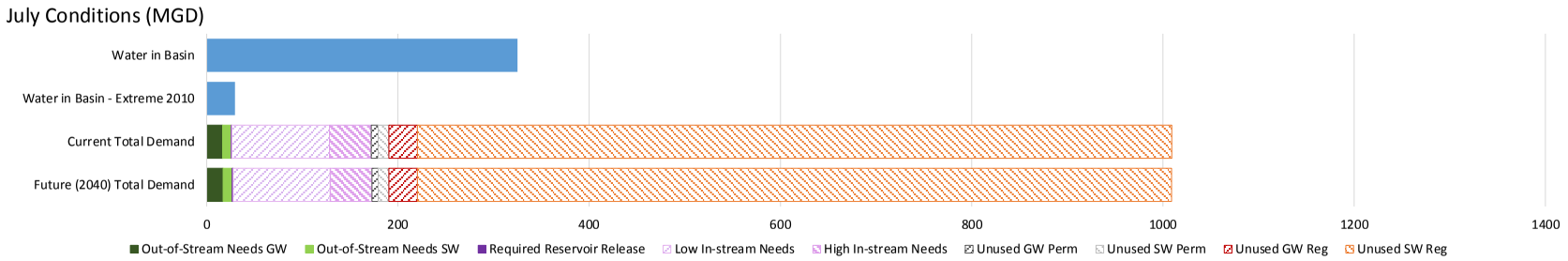
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	45.7	875	Water In
Wastewater Discharge	1.2	22.5	
Estimated Domestic Recharge	0.3	5.2	
Evapotranspiration	20.9	401	Water Out
Groundwater Withdrawals	0.8	14.9	
Surface Water Withdrawals	0.3	5.8	
Stormflow	14.7	283	Internal
Estimated Potential Recharge (EPR)	13.1	251	
Total Streamflow (Stormflow + EPR)	27.8	533	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	533	9.66	5.75	0.39	342.8		11.47	29.85	11.20	790.87
Future (2040) Conditions, ADD		10.01	5.84	0.67	342.8		10.96	29.85	11.20	790.78
Current Conditions, MMADD	325	16.64	9.20	0.39	102.6	146.3	7.22	29.85	11.20	788.83
Future (2040) Conditions, MMADD		17.19	9.32	1.23	102.6	146.3	6.52	29.85	11.20	788.71

Notes:

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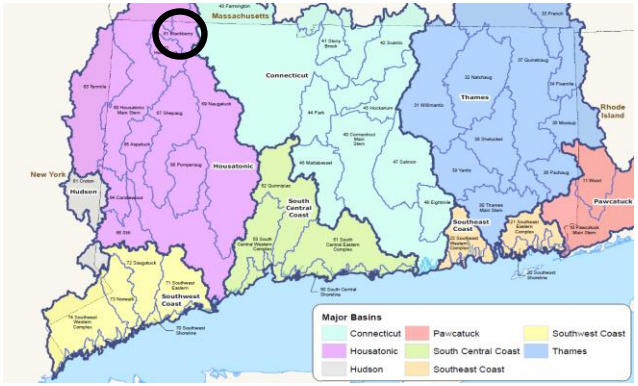
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Basin Water Summary

Regional Basin	**Blackberry**
Regional Basin No.	**61**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**34**

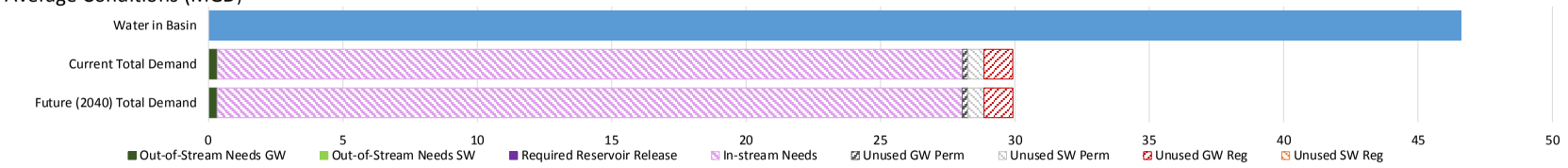
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.8	77	Water In
Wastewater Discharge	0.6	1.0	
Estimated Domestic Recharge	0.1	0.1	
Evapotranspiration	20.7	34	Water Out
Groundwater Withdrawals	0.3	0.4	
Surface Water Withdrawals	0.0	0.0	
Stormflow	14.9	24	Internal
Estimated Potential Recharge (EPR)	13.6	22	
Total Streamflow (Stormflow + EPR)	28.5	47	

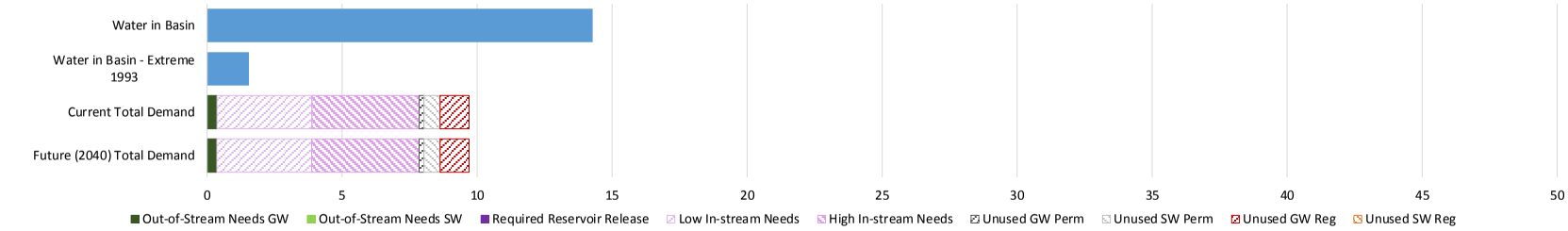


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	47	0.32	0.00	NA	27.7		0.20	1.07	0.60	0.00
Future (2040) Conditions, ADD		0.32	0.00	0.00	27.7		0.21	1.07	0.60	0.00
Current Conditions, MMADD	14	0.37	0.00	NA	3.5	7.5	0.17	1.07	0.60	0.00
Future (2040) Conditions, MMADD		0.36	0.00	0.00	3.5	7.5	0.18	1.07	0.60	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

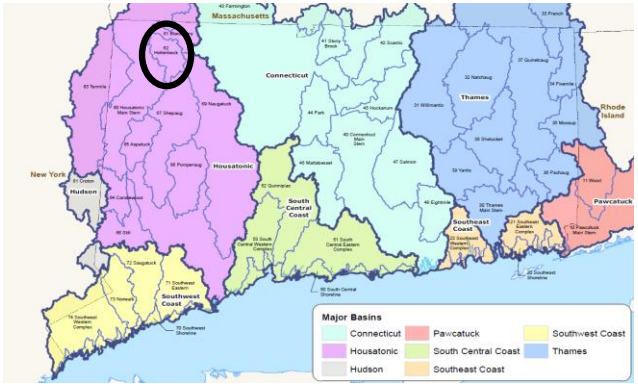
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Hollenbeck**
Regional Basin No.	**62**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**43**

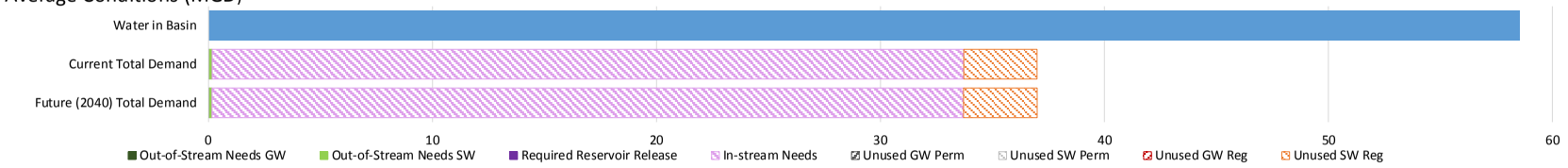
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.7	95	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.0	0.0	
Evapotranspiration	20.8	43	Water Out
Groundwater Withdrawals	0.0	0.1	
Surface Water Withdrawals	0.1	0.1	
Stormflow	14.7	30	Internal
Estimated Potential Recharge (EPR)	13.9	28	
Total Streamflow (Stormflow + EPR)	28.7	59	

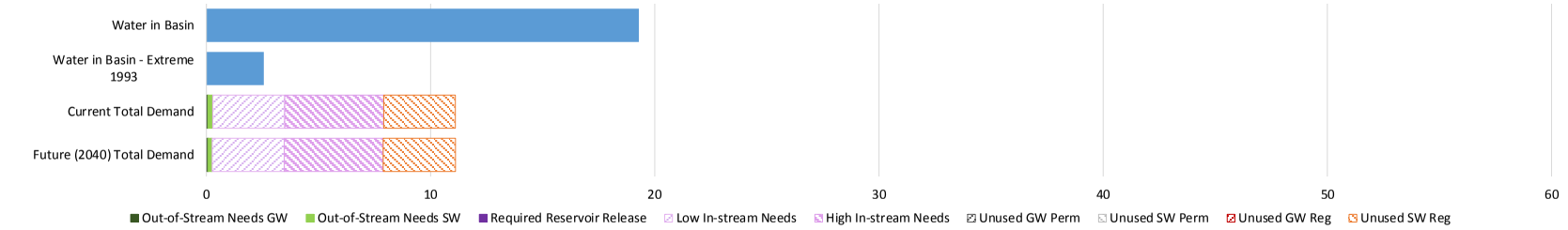


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	59	0.03	0.13	NA	33.6		0.00	0.00	0.00	3.27
Future (2040) Conditions, ADD		0.04	0.11	0.00	33.6		0.00	0.00	0.00	3.29
Current Conditions, MMADD	19	0.08	0.20	NA	3.2	7.6	0.00	0.00	0.00	3.20
Future (2040) Conditions, MMADD		0.08	0.18	0.00	3.2	7.6	0.00	0.00	0.00	3.22

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
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4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
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6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

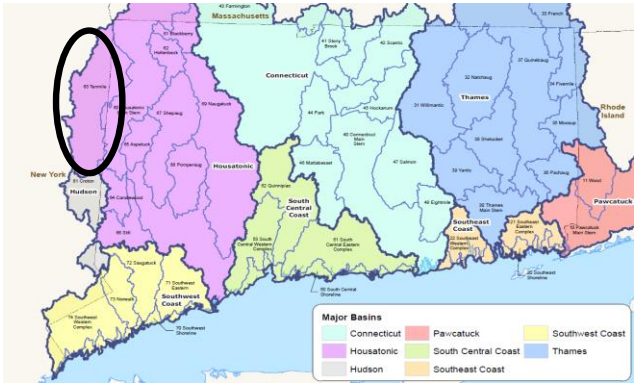
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Basin Water Summary

Regional Basin	**Tenmile**
Regional Basin No.	**63**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**36**

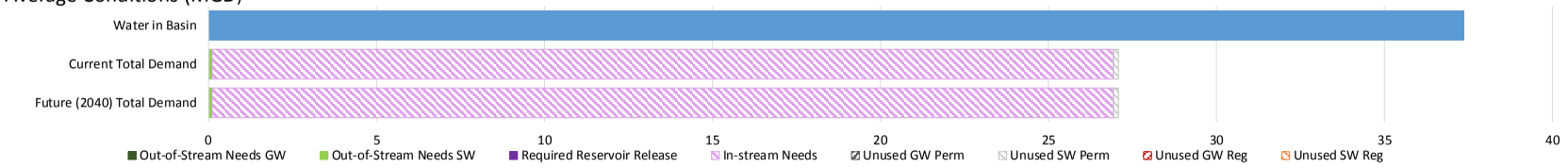
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.2	79	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.1	0.1	
Evapotranspiration	21.0	36	Water Out
Groundwater Withdrawals	0.1	0.1	
Surface Water Withdrawals	0.1	0.1	
Stormflow	10.6	18	Internal
Estimated Potential Recharge (EPR)	11.3	19	
Total Streamflow (Stormflow + EPR)	22.0	37	

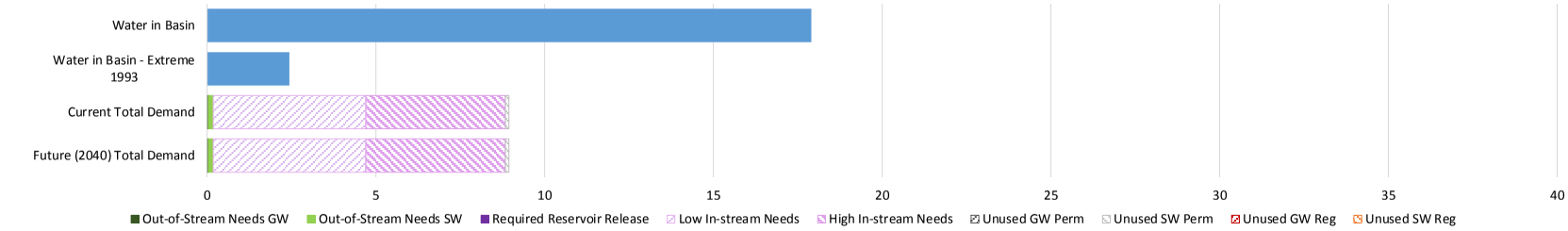


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	37	0.00	0.11	NA	26.8		0.00	0.00	0.14	0.00
Future (2040) Conditions, ADD		0.00	0.11	0.00	26.8		0.00	0.00	0.14	0.00
Current Conditions, MMADD	18	0.04	0.14	NA	4.5	8.7	0.00	0.00	0.10	0.00
Future (2040) Conditions, MMADD		0.04	0.14	0.00	4.5	8.7	0.00	0.00	0.10	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

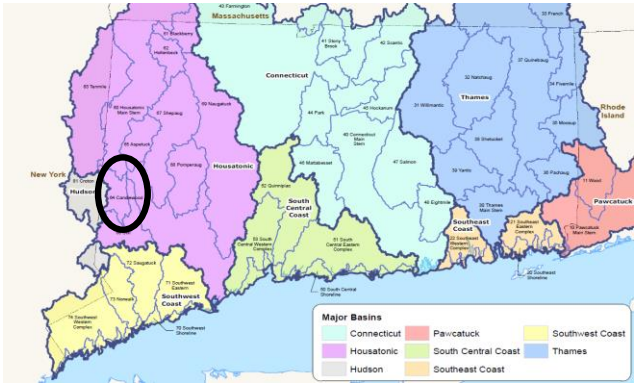
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Basin Water Summary

Regional Basin	**Candlewood**
Regional Basin No.	**64**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**39**

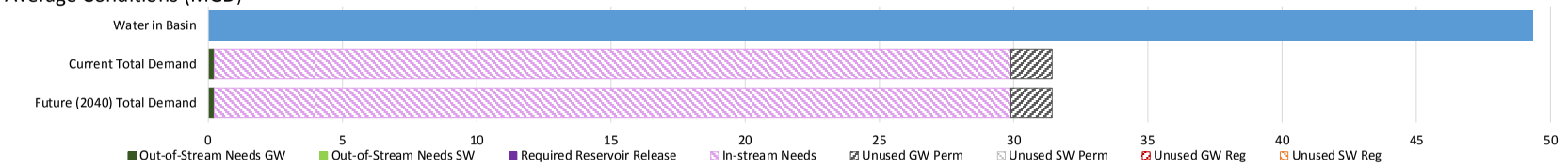
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	50.3	93	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.4	0.8	
Evapotranspiration	21.7	40	Water Out
Groundwater Withdrawals	0.5	1.0	
Surface Water Withdrawals	0.0	0.0	
Stormflow	12.9	24	Internal
Estimated Potential Recharge (EPR)	13.6	25	
Total Streamflow (Stormflow + EPR)	26.6	49	

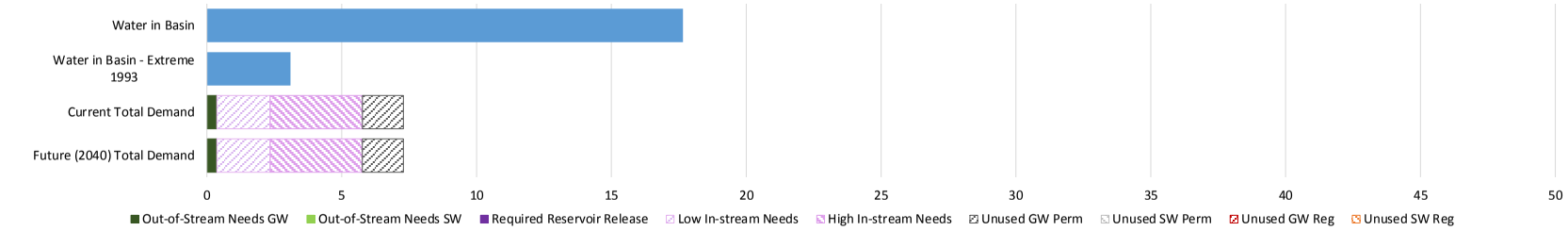


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	49	0.22	0.00	NA	29.7		1.53	0.00	0.00	0.00
Future (2040) Conditions, ADD		0.22	0.00	0.00	29.7		1.53	0.00	0.00	0.00
Current Conditions, MMADD	18	0.37	0.00	NA	2.0	5.4	1.52	0.00	0.00	0.00
Future (2040) Conditions, MMADD		0.37	0.00	0.00	2.0	5.4	1.52	0.00	0.00	0.00

Notes:

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4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

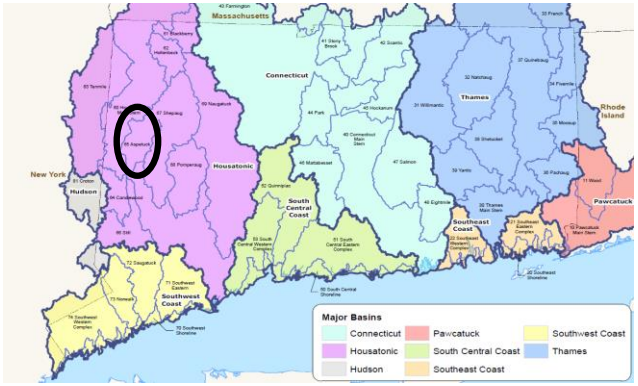
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Basin Water Summary

Regional Basin	**Aspetuck**
Regional Basin No.	**65**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**51**

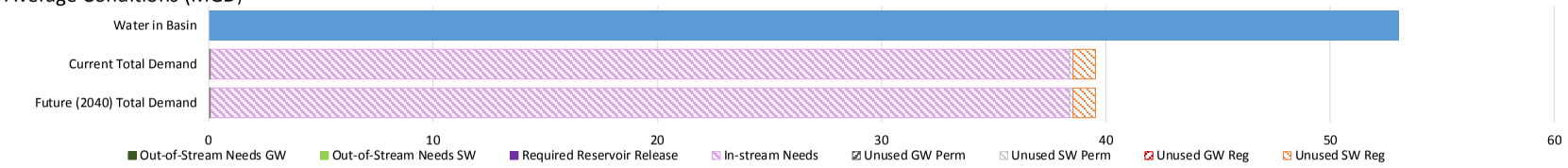
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.9	116	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.2	0.4	
Evapotranspiration	21.3	52	Water Out
Groundwater Withdrawals	0.2	0.5	
Surface Water Withdrawals	0.0	0.0	
Stormflow	11.1	27	Internal
Estimated Potential Recharge (EPR)	10.9	26	
Total Streamflow (Stormflow + EPR)	22.0	53	

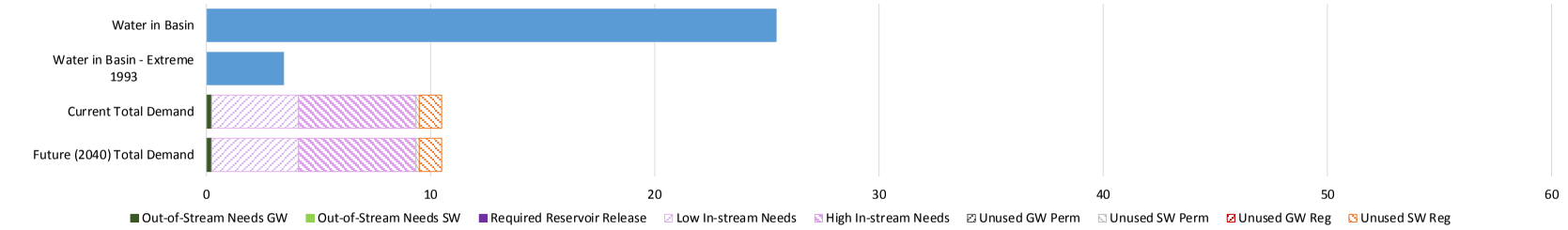


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	53	0.08	0.00	NA	38.3		0.00	0.00	0.15	1.00
Future (2040) Conditions, ADD		0.08	0.00	0.00	38.3		0.00	0.00	0.15	1.00
Current Conditions, MMADD	25	0.23	0.00	NA	3.9	9.1	0.00	0.00	0.15	1.00
Future (2040) Conditions, MMADD		0.23	0.00	0.00	3.9	9.1	0.00	0.00	0.15	1.00

Notes:

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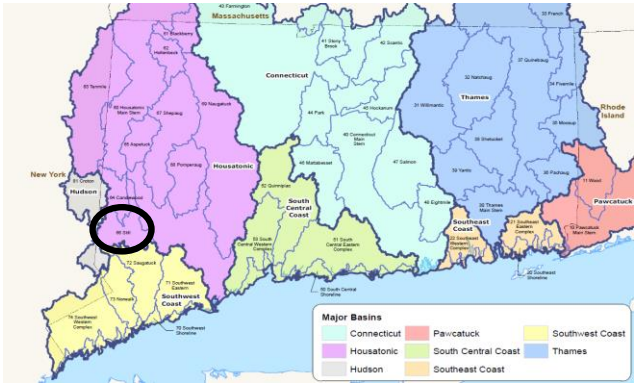
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Basin Water Summary

Regional Basin	**Still**
Regional Basin No.	**66**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**71**

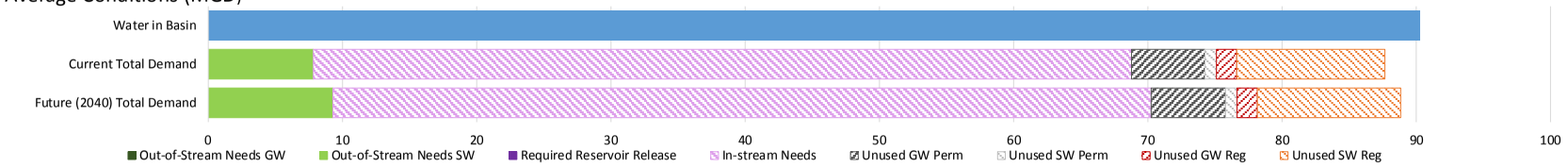
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	51.0	172	Water In
Wastewater Discharge	2.5	8.3	
Estimated Domestic Recharge	0.8	2.7	
Evapotranspiration	22.2	75	Water Out
Groundwater Withdrawals	0.8	2.6	
Surface Water Withdrawals	2.3	7.8	
Stormflow	13.5	45	Internal
Estimated Potential Recharge (EPR)	13.3	45	
Total Streamflow (Stormflow + EPR)	26.8	90	

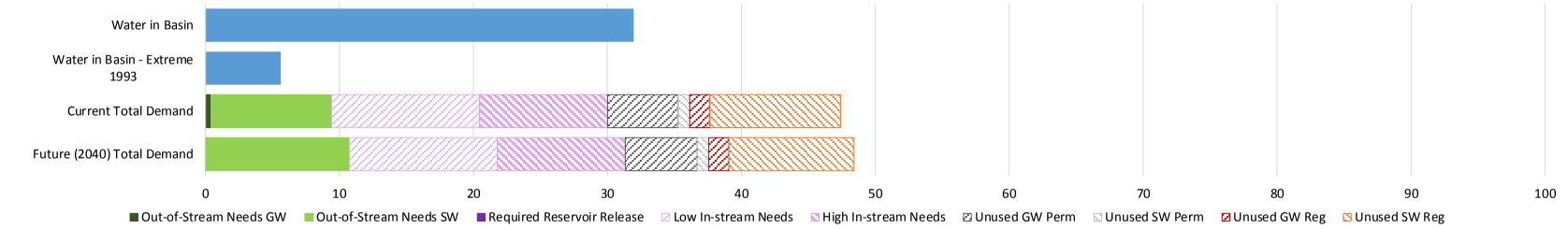


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	90	-0.05	7.83	NA	61.0		5.47	1.51	0.86	11.04
Future (2040) Conditions, ADD		-0.36	9.29	0.00	61.0		5.55	1.51	0.86	10.67
Current Conditions, MMADD	32	0.41	9.01	NA	11.0	20.6	5.28	1.51	0.86	9.75
Future (2040) Conditions, MMADD		0.06	10.69	0.00	11.0	20.6	5.37	1.51	0.86	9.32

Notes:

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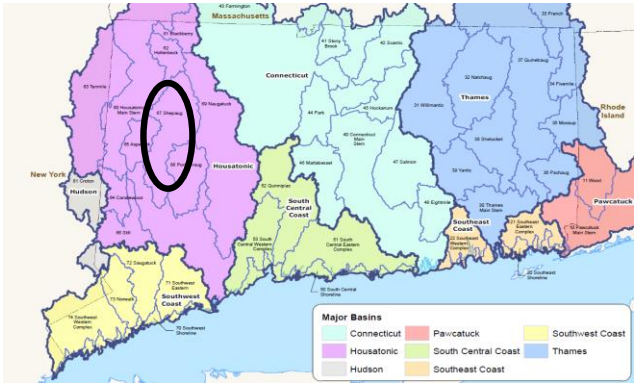
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Basin Water Summary

Regional Basin	**Shepaug**
Regional Basin No.	**67**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**155**

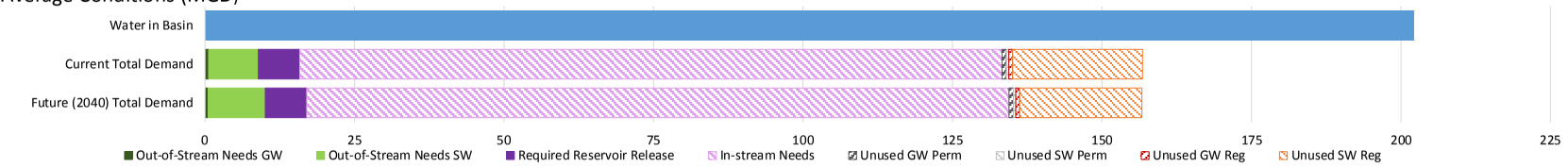
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.4	351	Water In
Wastewater Discharge	0.1	0.4	
Estimated Domestic Recharge	0.1	0.6	
Evapotranspiration	21.5	159	Water Out
Groundwater Withdrawals	0.2	1.3	
Surface Water Withdrawals	1.1	8.3	
Stormflow	14.3	106	Internal
Estimated Potential Recharge (EPR)	13.0	96	
Total Streamflow (Stormflow + EPR)	27.3	202	

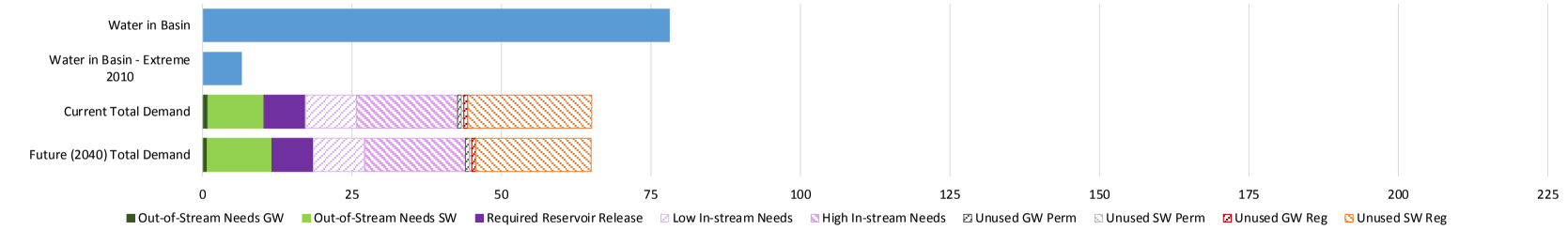


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	202	0.61	8.31	6.93	124.4		0.72	0.65	0.40	21.72
Future (2040) Conditions, ADD		0.51	9.58	6.93	124.4		0.71	0.65	0.40	20.46
Current Conditions, MMADD	78	0.87	9.40	6.93	15.5	32.4	0.66	0.65	0.40	20.73
Future (2040) Conditions, MMADD		0.77	10.82	6.93	15.5	32.4	0.66	0.65	0.40	19.31

Notes:

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6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

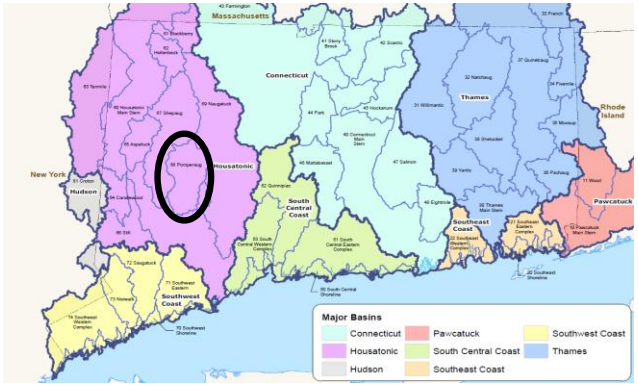
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Pomperaug**
Regional Basin No.	**68**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**89**

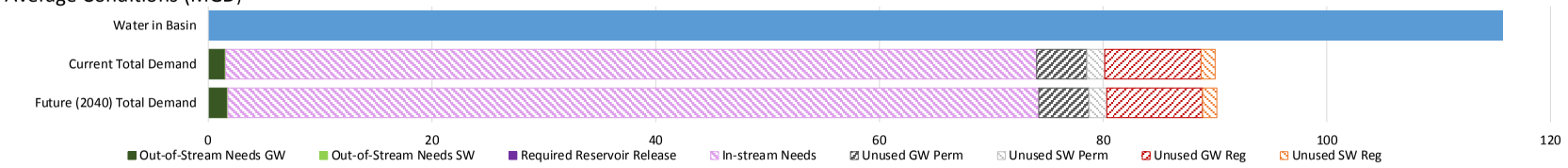
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	47.1	199	Water In
Wastewater Discharge	0.1	0.4	
Estimated Domestic Recharge	0.3	1.1	
Evapotranspiration	21.9	93	Water Out
Groundwater Withdrawals	0.6	2.6	
Surface Water Withdrawals	0.0	0.1	
Stormflow	14.5	62	Internal
Estimated Potential Recharge (EPR)	12.8	54	
Total Streamflow (Stormflow + EPR)	27.3	116	

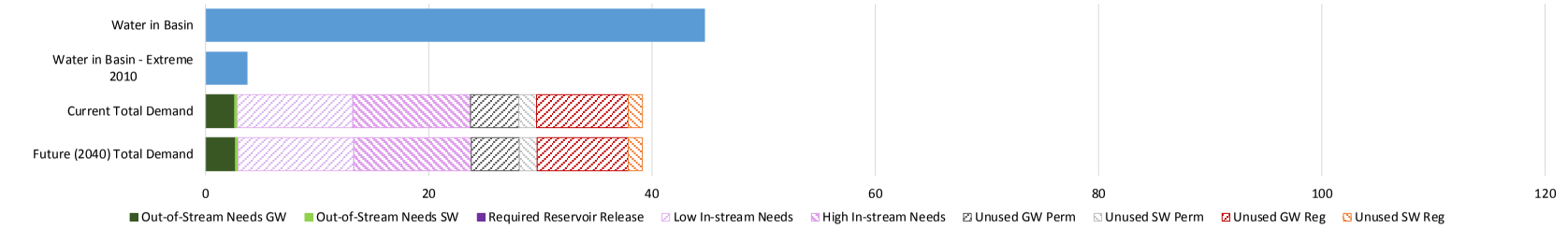


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	116	1.50	0.05	NA	72.5		4.50	8.61	1.59	1.27
Future (2040) Conditions, ADD		1.70	0.05	0.00	72.5		4.48	8.57	1.59	1.27
Current Conditions, MMADD	45	2.61	0.25	NA	10.3	20.9	4.34	8.20	1.59	1.27
Future (2040) Conditions, MMADD		2.69	0.25	0.00	10.3	20.9	4.32	8.15	1.59	1.27

Notes:

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3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
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5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

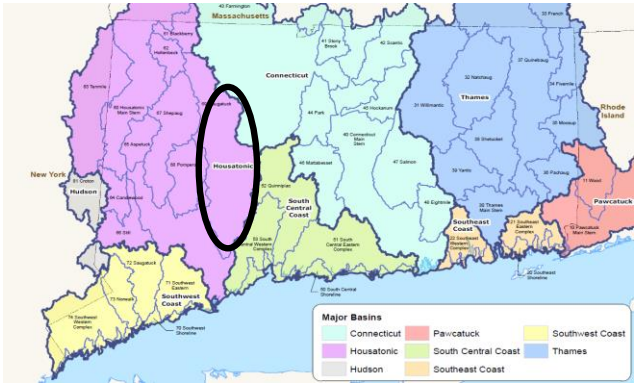
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Naugatuck**
Regional Basin No.	**69**
Major Basin	**Housatonic**
Size of Basin in CT (mi^2)	**311**

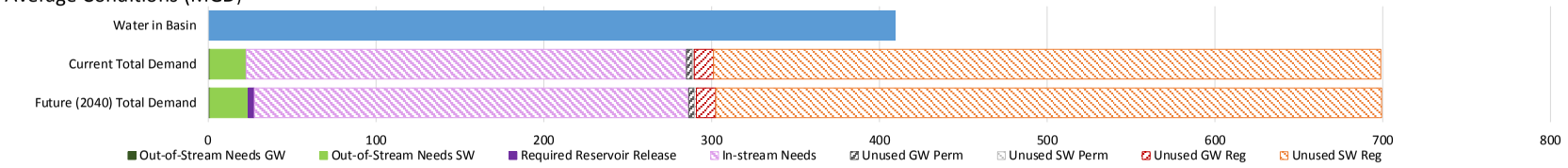
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	45.4	672	Water In
Wastewater Discharge	2.1	31.7	
Estimated Domestic Recharge	0.3	5.2	
Evapotranspiration	22.1	327	Water Out
Groundwater Withdrawals	0.4	6.1	
Surface Water Withdrawals	1.5	21.6	
Stormflow	14.4	214	Internal
Estimated Potential Recharge (EPR)	13.2	196	
Total Streamflow (Stormflow + EPR)	27.6	409	

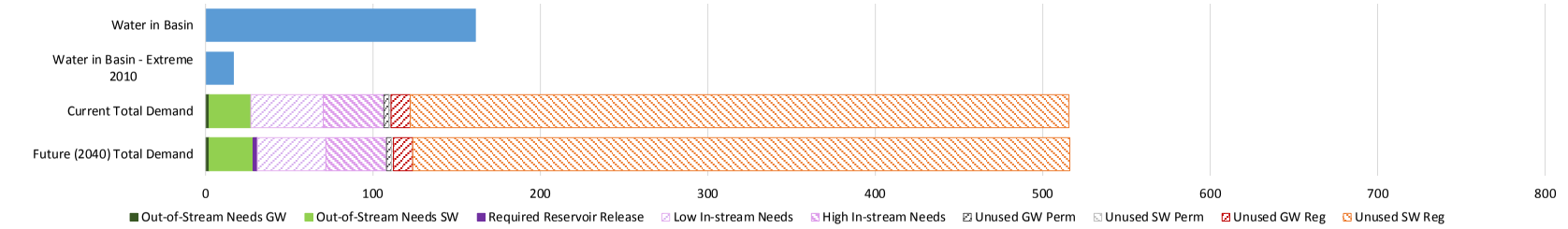


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	409	0.97	21.60	NA	262.4		3.53	11.49	1.18	397.70
Future (2040) Conditions, ADD		0.94	23.00	3.49	262.4		3.42	11.49	1.18	396.91
Current Conditions, MMADD	161	2.16	24.89	NA	43.3	79.5	3.08	11.49	1.18	393.40
Future (2040) Conditions, MMADD		2.16	26.46	2.33	43.3	79.5	2.96	11.48	1.18	392.46

Notes:

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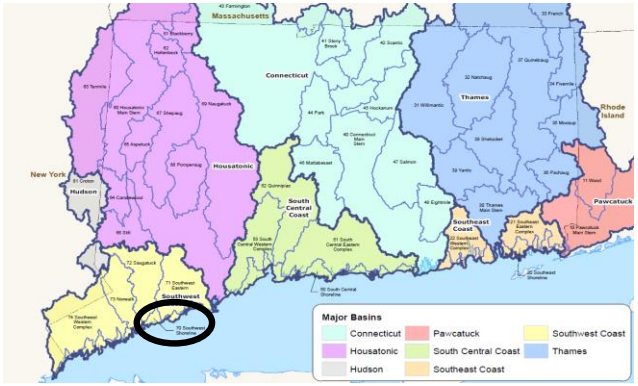
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Basin Water Summary

Regional Basin	**Southwest Shoreline**
Regional Basin No.	**70**
Major Basin	**Southwest Coast**
Size of Basin in CT (mi^2)	**39**

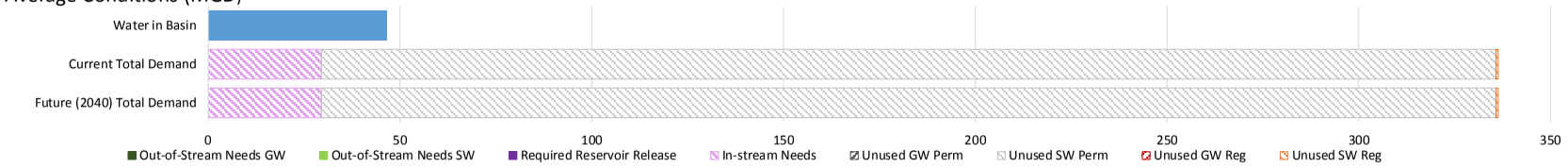
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	49.6	92	Water In
Wastewater Discharge	31.8	59.4	
Estimated Domestic Recharge	0.5	0.9	
Evapotranspiration	23.7	44	Water Out
Groundwater Withdrawals	0.0	0.0	
Surface Water Withdrawals	0.0	0.0	
Stormflow	12.3	23	Internal
Estimated Potential Recharge (EPR)	12.6	24	
Total Streamflow (Stormflow + EPR)	24.9	46	

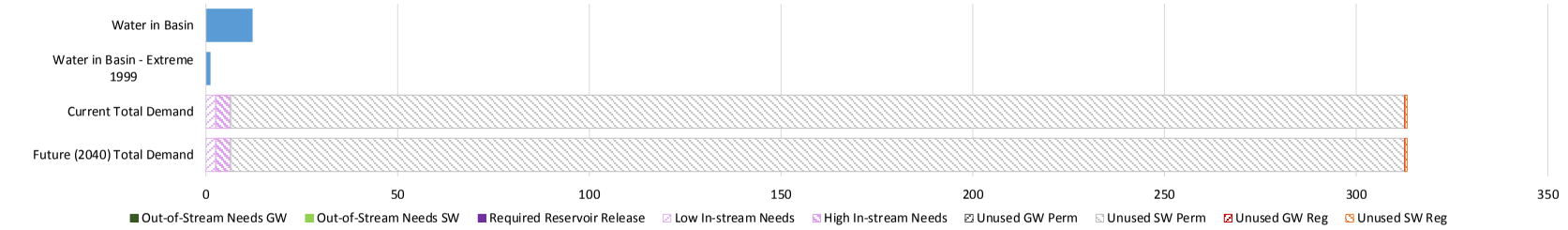


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	46	-0.89	0.00	NA	29.5		0.00	0.03	306.30	0.53
Future (2040) Conditions, ADD		-0.89	0.00	0.00	29.5		0.00	0.03	306.30	0.53
Current Conditions, MMADD	12	-0.88	0.00	NA	2.6	6.5	0.00	0.03	306.30	0.53
Future (2040) Conditions, MMADD		-0.88	0.00	0.00	2.6	6.5	0.00	0.03	306.30	0.53

Notes:

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3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
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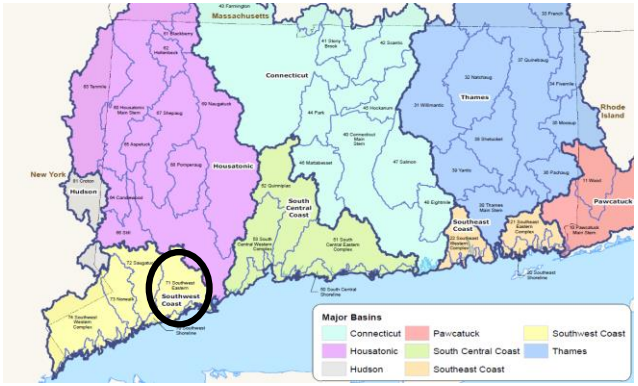
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

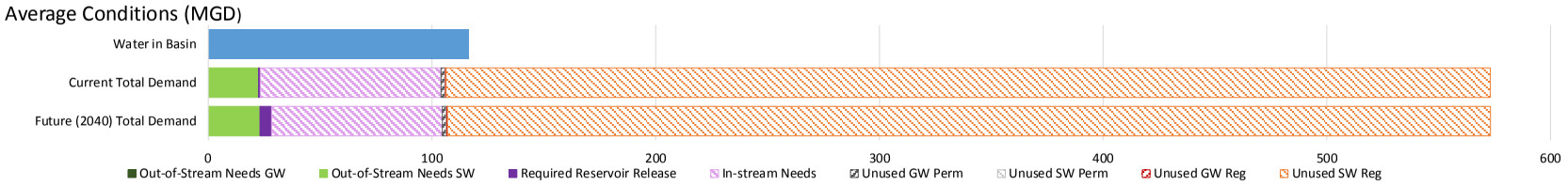
Regional Basin	**Southwest Eastern**
Regional Basin No.	**71**
Major Basin	**Southwest Coast**
Size of Basin in CT (mi^2)	**98**

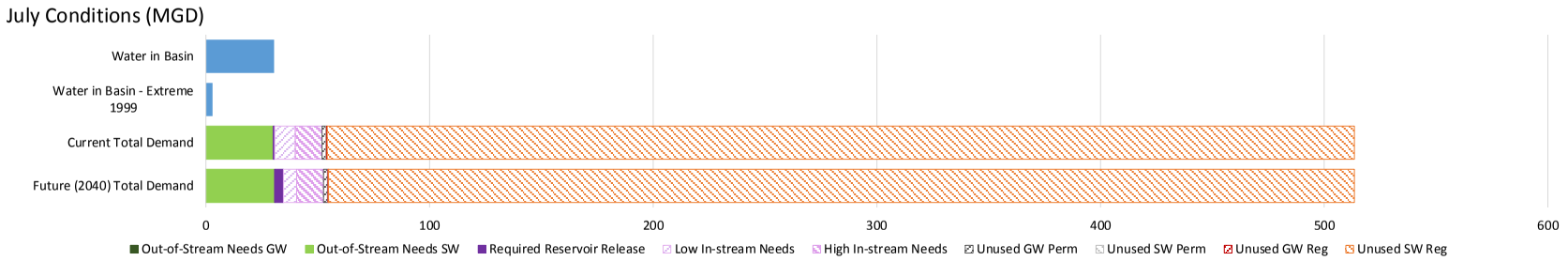
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	46.5	217	Water In
Wastewater Discharge	0.1	0.3	
Estimated Domestic Recharge	0.5	2.2	
Evapotranspiration	23.4	109	Water Out
Groundwater Withdrawals	0.1	0.3	
Surface Water Withdrawals	4.8	22.5	
Stormflow	13.1	61	Internal
Estimated Potential Recharge (EPR)	11.8	55	
Total Streamflow (Stormflow + EPR)	24.9	116	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	116	-1.95	22.47	0.71	81.6		1.78	0.29	0.20	466.74
Future (2040) Conditions, ADD		-2.00	23.08	5.18	81.6		1.78	0.29	0.20	466.28
Current Conditions, MMADD	31	-1.86	30.08	0.71	9.9	21.9	1.78	0.29	0.20	459.28
Future (2040) Conditions, MMADD		-1.90	30.69	3.96	9.9	21.9	1.78	0.29	0.20	458.67

Notes:

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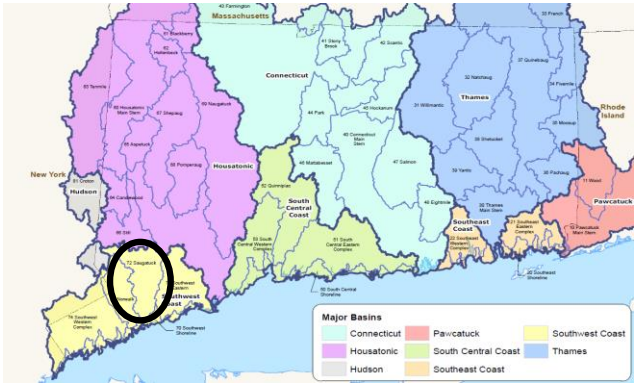
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Basin Water Summary

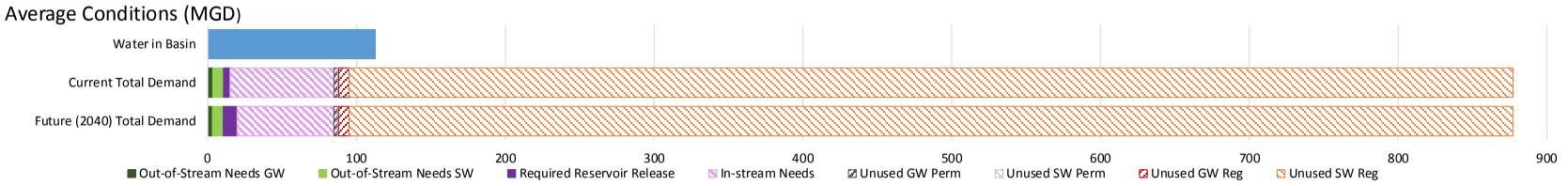
Regional Basin	**Saugatuck**
Regional Basin No.	**72**
Major Basin	**Southwest Coast**
Size of Basin in CT (mi^2)	**89**

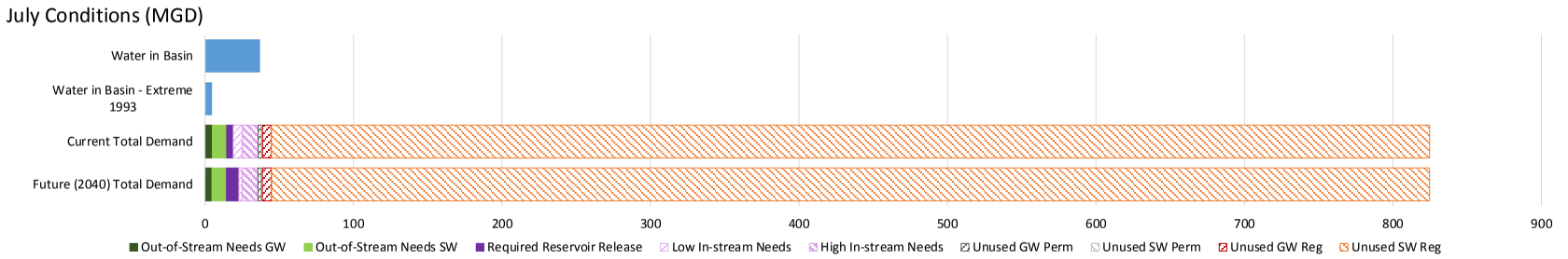
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	50.2	214	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.4	1.8	
Evapotranspiration	23.0	98	Water Out
Groundwater Withdrawals	1.2	5.1	
Surface Water Withdrawals	1.7	7.3	
Stormflow	13.7	59	Internal
Estimated Potential Recharge (EPR)	12.7	54	
Total Streamflow (Stormflow + EPR)	26.4	112	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	112	3.28	7.25	4.40	74.4		2.35	7.05	0.67	782.34
Future (2040) Conditions, ADD		3.01	7.40	9.21	74.4		2.35	7.21	0.67	782.19
Current Conditions, MMADD	37	4.95	9.65	4.40	10.5	21.1	2.35	6.03	0.67	779.95
Future (2040) Conditions, MMADD		4.62	9.85	8.34	10.5	21.1	2.35	6.24	0.67	779.75

Notes:

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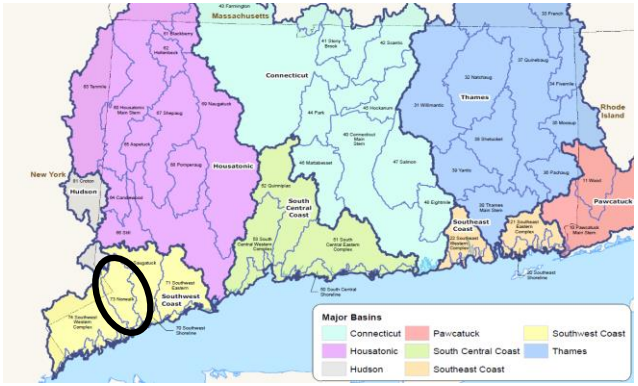
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Basin Water Summary

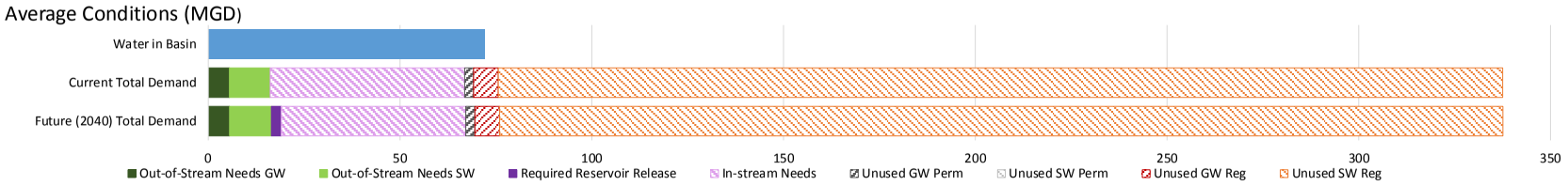
Regional Basin	**Norwalk**
Regional Basin No.	**73**
Major Basin	**Southwest Coast**
Size of Basin in CT (mi^2)	**58**

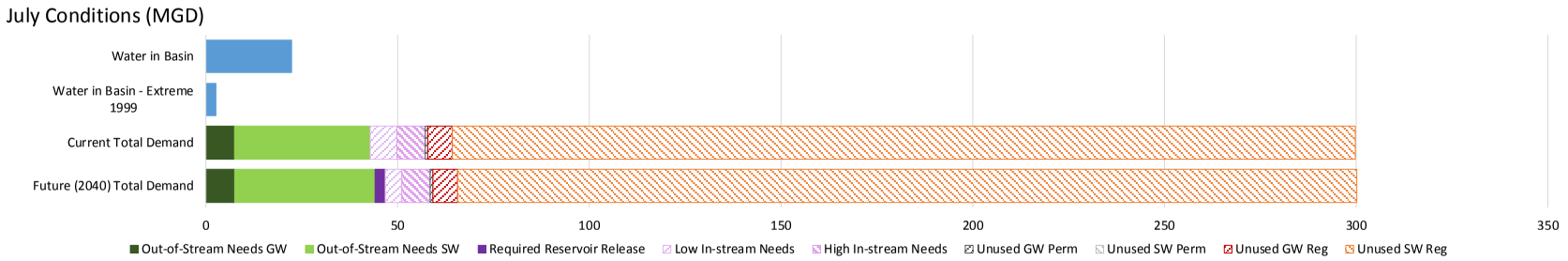
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	51.7	143	Water In
Wastewater Discharge	4.9	13.5	
Estimated Domestic Recharge	0.6	1.6	
Evapotranspiration	23.2	64	Water Out
Groundwater Withdrawals	2.6	7.1	
Surface Water Withdrawals	3.8	10.6	
Stormflow	13.4	37	Internal
Estimated Potential Recharge (EPR)	12.6	35	
Total Streamflow (Stormflow + EPR)	26.0	72	



Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)





	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	72	5.52	10.63	NA	50.7		2.32	6.44	0.00	261.91
Future (2040) Conditions, ADD		5.54	10.91	2.58	50.7		2.39	6.44	0.00	261.63
Current Conditions, MMADD	22	7.47	35.39	NA	7.0	14.3	0.65	6.43	0.00	235.51
Future (2040) Conditions, MMADD		7.50	36.64	2.62	7.0	14.3	0.74	6.43	0.00	234.51

Notes:

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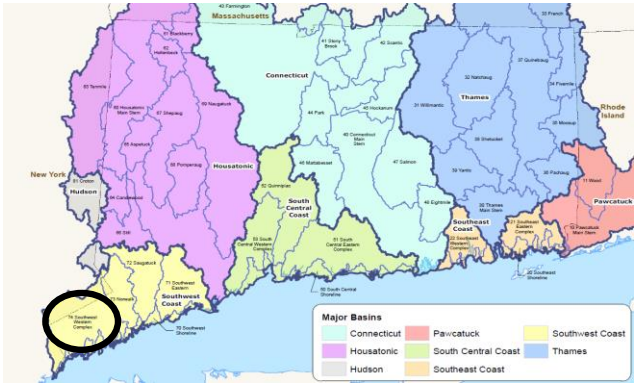
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Basin Water Summary

Regional Basin	**Southwest Western**
Regional Basin No.	**74**
Major Basin	**Southwest Coast**
Size of Basin in CT (mi^2)	**104**

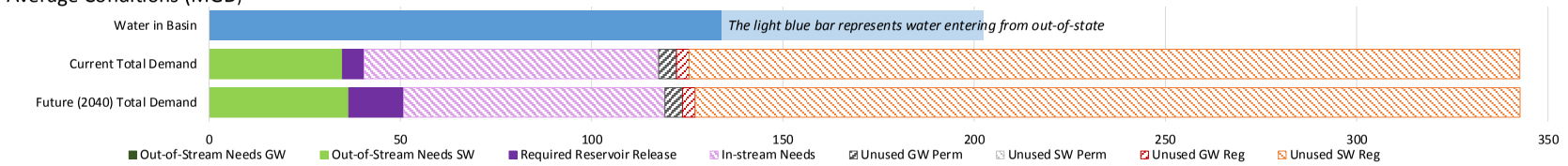
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	52.4	260	Water In
Wastewater Discharge	0.2	1.0	
Estimated Domestic Recharge	0.5	2.6	
Evapotranspiration	23.3	116	Water Out
Groundwater Withdrawals	0.4	1.8	
Surface Water Withdrawals	7.0	34.9	
Stormflow	14.3	71	Internal
Estimated Potential Recharge (EPR)	12.7	63	
Total Streamflow (Stormflow + EPR)	27.0	134	

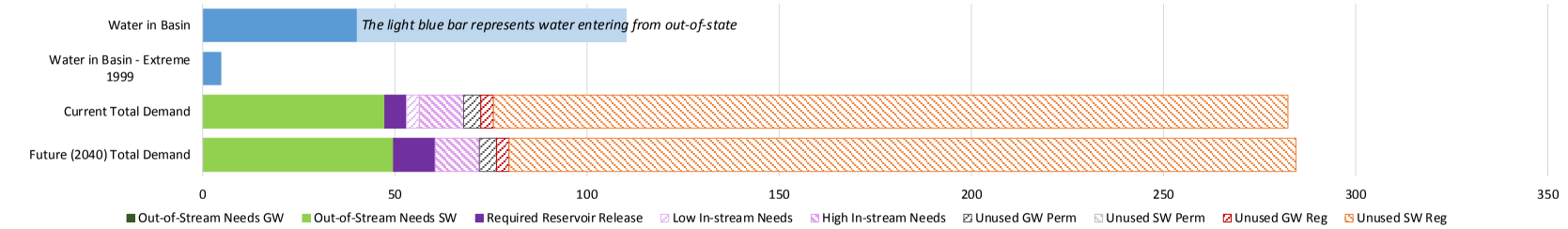


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Water Flowing from MA	Net Groundwater Demands	Surface Water Demands: Out-of-stream Needs	Surface Water Demands: Reservoir Release	Surface Water Demands: In-stream Needs		Unused Groundwater: Perm	Unused Groundwater: Reg	Unused Surface Water: Perm	Unused Surface Water: Reg
Current Conditions, ADD	134	68	-0.85	34.89	5.62	82.6		4.67	3.29	0.00	217.17
Future (2040) Conditions, ADD			-0.88	36.52	14.32	82.6		4.65	3.29	0.00	215.62
Current Conditions, MMADD	40	20	-0.20	47.43	5.62	9.0	20.5	4.49	3.29	0.00	206.72
Future (2040) Conditions, MMADD			-0.20	49.66	10.83	9.0	20.5	4.45	3.29	0.00	204.69

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

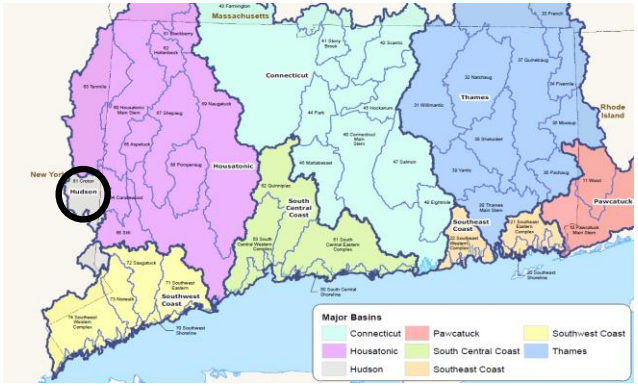
Disclaimer: This Water Basin Summary sheet is part of a State-wide screening tool and is not intended to be used as stand-alone guidance.

Basin Water Summary

Regional Basin	**Croton**
Regional Basin No.	**81**
Major Basin	**Hudson**
Size of Basin in CT (mi^2)	**21**

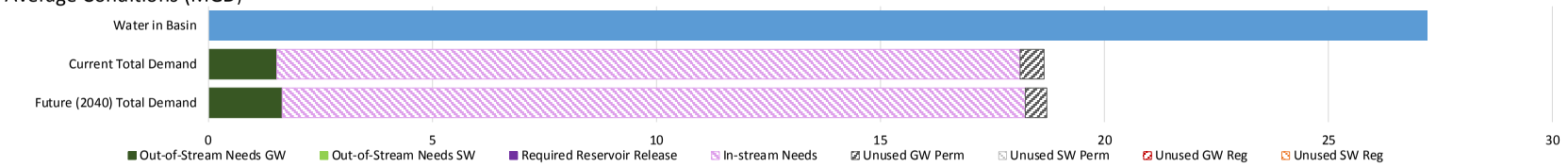
Catalog of Internal and External Flows in Basin

	IN/YR	MGD	
Precipitation	51.2	51	Water In
Wastewater Discharge	0.0	0.0	
Estimated Domestic Recharge	0.5	0.5	
Evapotranspiration	21.9	22	Water Out
Groundwater Withdrawals	2.0	2.0	
Surface Water Withdrawals	0.0	0.0	
Stormflow	13.3	13	Internal
Estimated Potential Recharge (EPR)	13.9	14	
Total Streamflow (Stormflow + EPR)	27.2	27	

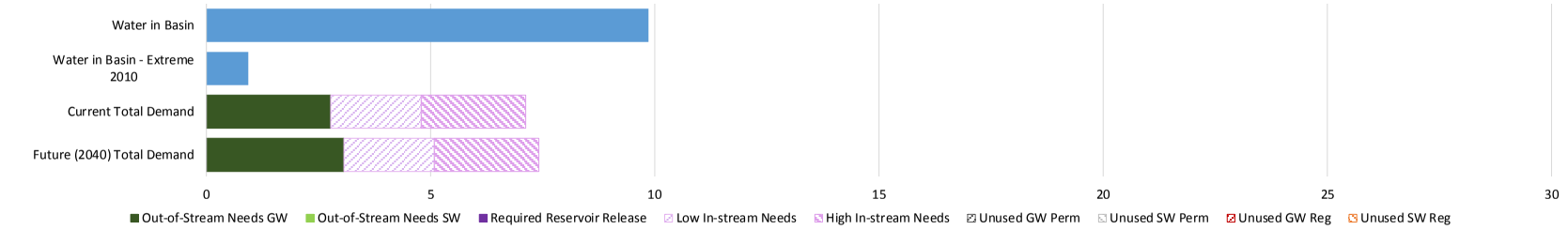


Water Availability and Demand (MGD) - Including Estimated Ecological Flows, Regulatory Reservoir Releases, and Unused Registrations (Reg) and Permits (Perm)

Average Conditions (MGD)



July Conditions (MGD)



	Water in Basin	Net Groundwater Demands	Surface Water Demands				Unused Groundwater		Unused Surface Water	
			Out-of-stream Needs	Reservoir Release	In-stream Needs		Perm	Reg	Perm	Reg
Current Conditions, ADD	27	1.52	0.00	NA	16.6		0.54	0.00	0.00	0.00
Future (2040) Conditions, ADD		1.64	0.00	0.00	16.6		0.48	0.00	0.00	0.00
Current Conditions, MMADD	10	2.77	0.00	NA	2.0	4.3	-0.43	0.00	0.00	0.00
Future (2040) Conditions, MMADD		3.07	0.00	0.00	2.0	4.3	-0.52	0.00	0.00	0.00

Notes:

1. Average Daily Demand (ADD) is the average estimated water withdrawn from the system on any day in the year.
2. Maximum Monthly Average Daily Demand (MMADD) is the average estimated daily water withdrawn from the system during July, which typically has the highest average monthly demands.
3. Net groundwater demand accounts for the difference between groundwater withdraws and estimated recharge through on-site wastewater systems.
4. "Water in Basin" accounts for water originating within the basin (CT portion only). Not all water in a basin is accessible or classified to support all existing or potential uses.
5. "Water in Basin - Extreme" refers to the lowest July streamflow on record during the period 1985-2015.
6. Required Reservoir Releases reflect estimated Minimum and Multi Level Release Rule amounts. They do not account for possible exemptions. The in-stream needs are calculated using the USGS StreamStats program. The Q50 is presented for average annual conditions, and a range is provided for July conditions, based on the Q80 (Low In-stream Needs) and Q50 (High In-stream Needs) for the July-Oct bioperiod.

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APPENDIX F

Hybrid Delta Ensemble Method - Climate Change Evaluation

and

Climate Change Steamflow Projections

Hybrid Delta Ensemble Method

The hybrid delta ensemble (HDe) method is a numerical approach used to incorporate downscaled global climate model (GCM) projections into a water resources planning study. The method was originally developed by the Bureau of Reclamation (Reclamation, 2010). The method is well suited for water supply planning studies and can be used to generate inputs to hydrologic models. The HDe method is generally applied using monthly climate model projections and a specific future planning horizon.

The "ensemble" term in the HDe name refers to the fact that a group of projections are combined and used jointly, rather than applied discretely. "Delta" refers to the fact only modeled *changes* in climate (modeled future vs. modeled past), rather than the modeled climate values themselves, are used to forecast future conditions. As described below, modeled delta values are used to adjust a historical observed data set to reflect future conditions. Lastly, the "hybrid" descriptor refers to the mathematical approach employed, which can be thought of as a combination of statistical methods and discrete point methods (e.g. stochastic sampling of the data). In the HDe approach, monthly ranked percentile distributions are fitted to the entire ensemble data set, for use in subsequent analysis. This is in contrast to, for example, pure statistical methods that might only use monthly ensemble mean values to adjust a data set.

Noted advantages of the HDe method, compared to other published options, include:

- The use of projection ensembles, rather than a small number of hand-picked discrete projections, ensures that the variability and uncertainty inherent in the GCM projections is retained in subsequent calculations.
- The ensemble approach also avoids the need to hand pick a small sub set from a larger set of equally plausible projections, thereby eliminating concerns about "cherry picking".
- The delta approach minimizes the impacts of any model bias by only using modeled vs. modeled relative differences.
- By applying deltas to a historical observed record, the projections of future climate are well grounded in past realities and retain observed patterns of hydroclimate variability. This approach also avoids the direct use of long term temporal (e.g. year to year) climate patterns projected by the GCMs, which are recognized for their low confidence levels. For these reasons, and HDe adjusted climate timeseries is often more palatable to a wide stakeholder group compared to the direct use of climate projection traces.
- The hybrid mathematical technique ensures that the full range of variability projected by the model ensemble is appropriately captured in the adjusted timeseries. Data smoothing, often a byproduct of other ensemble methods (such as those that only employ mean values), is minimized in the HDe approach.

The specific calculation steps in the HDe method are described below.

1. For each downscaled GCM projection to be included (as downloaded, for example, from http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html), annual

anomalies are calculated for mean annual temperature and precipitation (or any other discriminator metrics). The annual anomalies are calculated based on the difference between modeled future climate vs. modeled past climate, for a selected future planning horizon and historical hindcast (or "overlap") period. These anomalies are generally calculated as a percent change for annual precipitation and a difference term for annual temperature.

2. A scatter plot of annual anomalies, for a given planning horizon and with each point corresponding to a specific GCM projection, is constructed. The plot is generally sub-divided into quantiles by 25^{th}, 50^{th} and 75^{th} percentile lines. These quantiles include the four quartile regions created by the intersection of the median anomaly lines, an interquartile region bounded by the intersecting 25^{th} and 75^{th} percentile lines, and four outer quantile regions created by the intersection of the 25^{th} and 75^{th} percentile lines, respectively. See **Figure 1** for an example. Ensembles of data are then constructed, guided by these graphed annual anomalies. For example, it may be desirable to create four unique ensembles using the four major quartiles: hot/dry (upper left), hot/wet (upper right), warm/dry (lower left), and warm/wet (lower right). Often a fifth ensemble, representing the central tendency of the data, is included based on the interquartile range (center box); however, it was not used in this analysis.
3. For each constructed ensemble, rank percentile distributions are calculated for each calendar month and each climate variable (e.g. monthly precipitation and temperature). Distributions are calculated for both a modeled future period (e.g. 2040 $\pm$ 10 years) and a modeled past period (e.g. 1950 – 1999).
4. The calculation then proceeds in sequential fashion, whereby each record in an observed historical climate timeseries (usually monthly) is adjusted. For each observed climate record, a relative percentile is calculated based on the ranked position of that record in the larger observed data set for that calendar month. Corresponding percentile values of model future and modeled past (from the distributions developed in Step 3) are then used to calculate climate delta values. For precipitation, these deltas are in the form of ratios (modeled future / modeled past); while for temperature, the deltas are calculated as differences (modeled future – modeled past). For example, if July 1950 was a particularly hot July (e.g. 90^{th} percentile of observed data), then the temperature delta term is calculated as the difference between the 90^{th} percentile modeled future July temperature and the 90^{th} percentile modeled past July temperature ($T_{90,\ July,\ Future} - T_{90,\ July,\ Past}$). The Delta factors, or terms, are then applied to the historical observed data points to generate an adjusted climate data set, reflective of projected planning horizon climate conditions.
5. The adjusted climate data sets, for each constructed ensemble, are then available for use in subsequent water resources analyses and modeling. Often such subsequent modeling might similarly employ a "delta" approach. For example, a hydrologic model, driven by the two sets of climate data (historical observed and adjusted future), might be used to generate stream flow delta factors. Examples of final HDe output are shown in **Figure 2**.

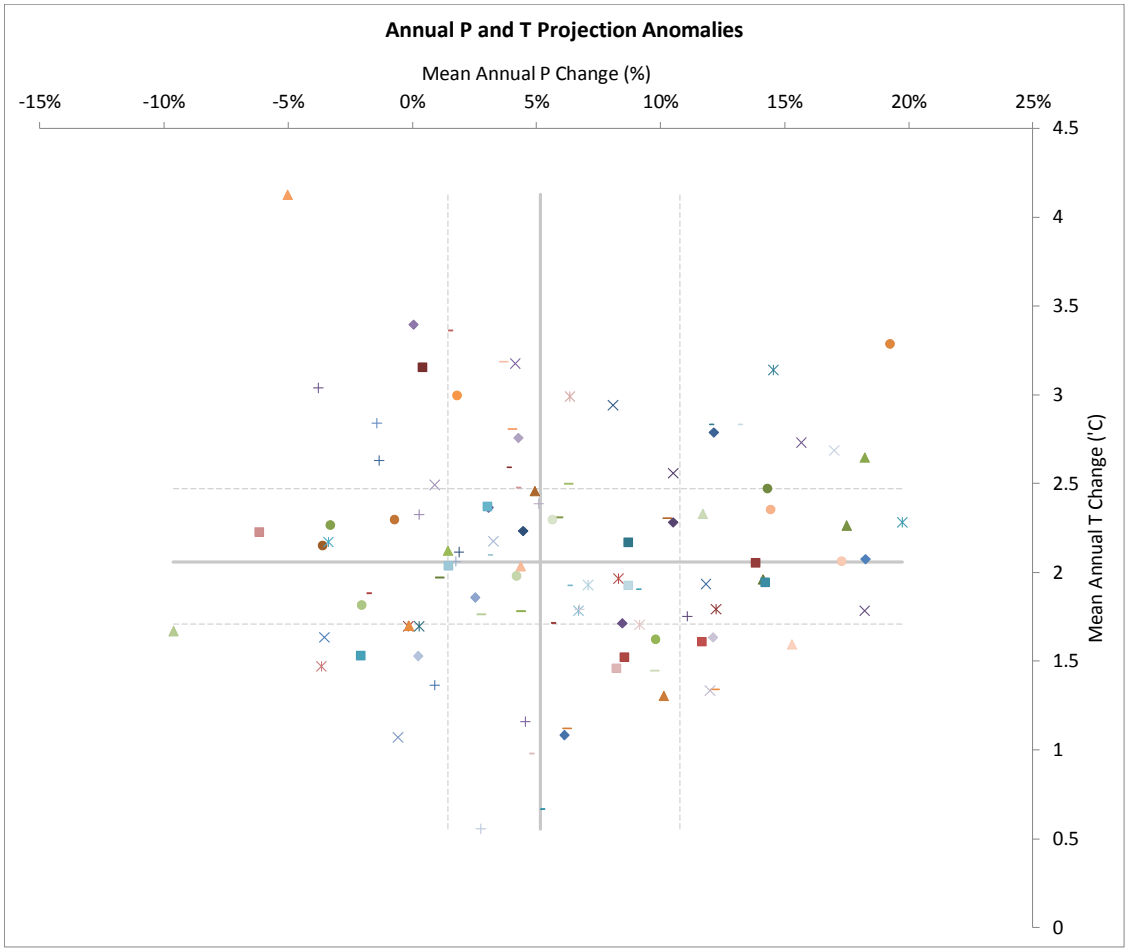


Figure 1. Example GCM Annual Anomaly Plot. Dashed grey lines indicate 25th and 75th percentiles. Solid grey lines indicated median values. Each symbol corresponds to a unique GCM projection.

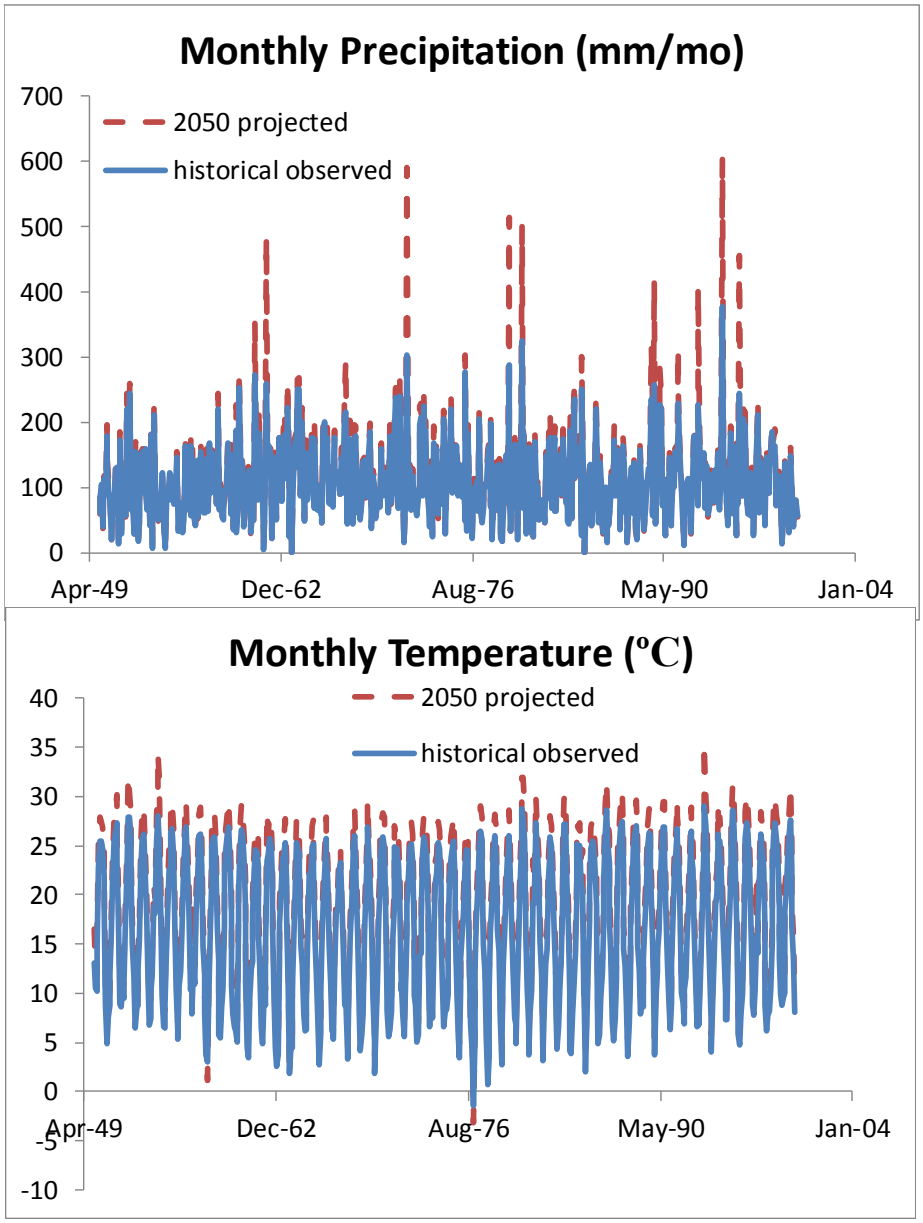
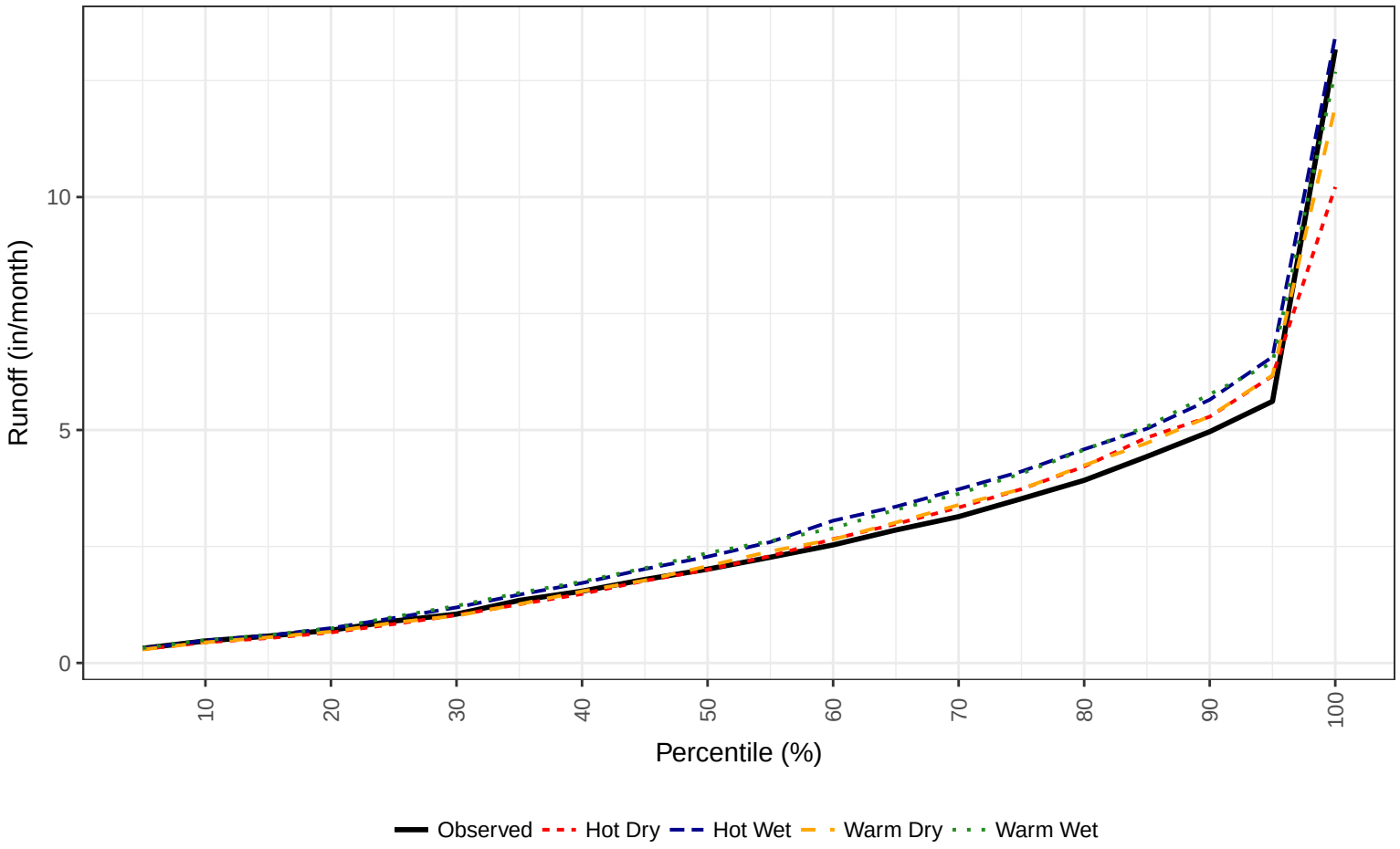
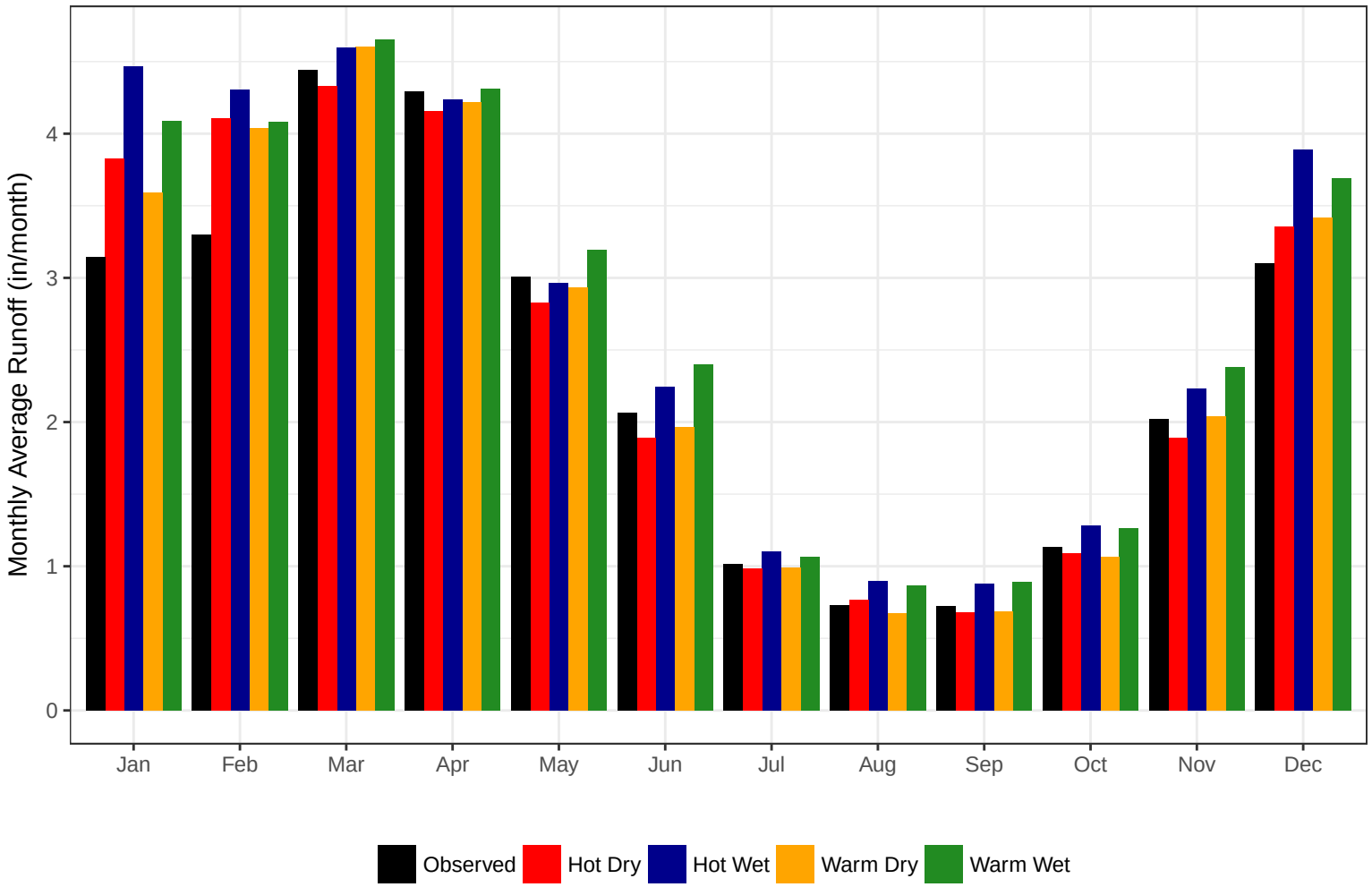


Figure 2. Example Final HDe Output: Adjusted Climate Timeseries. 2050 Planning Horizon

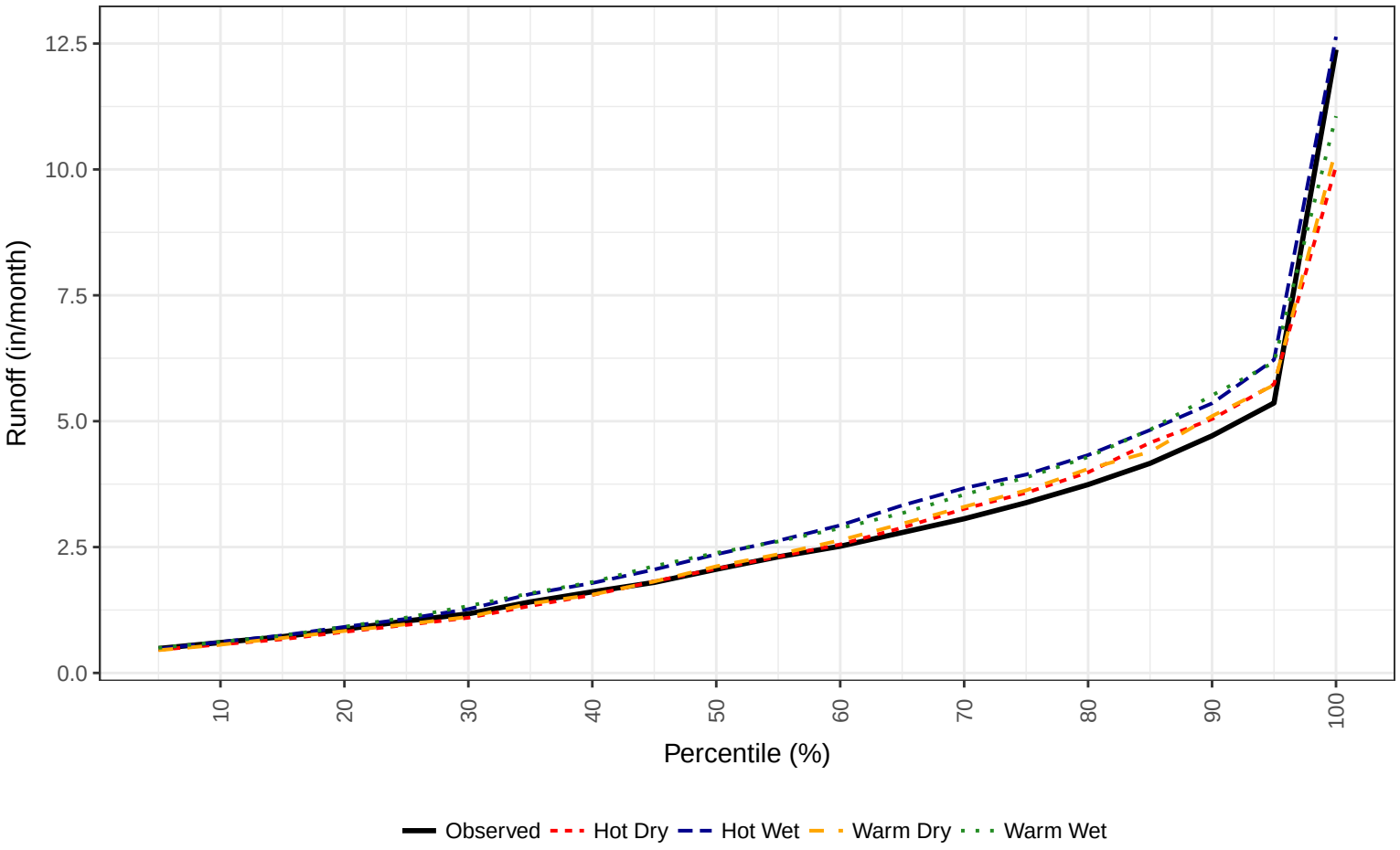
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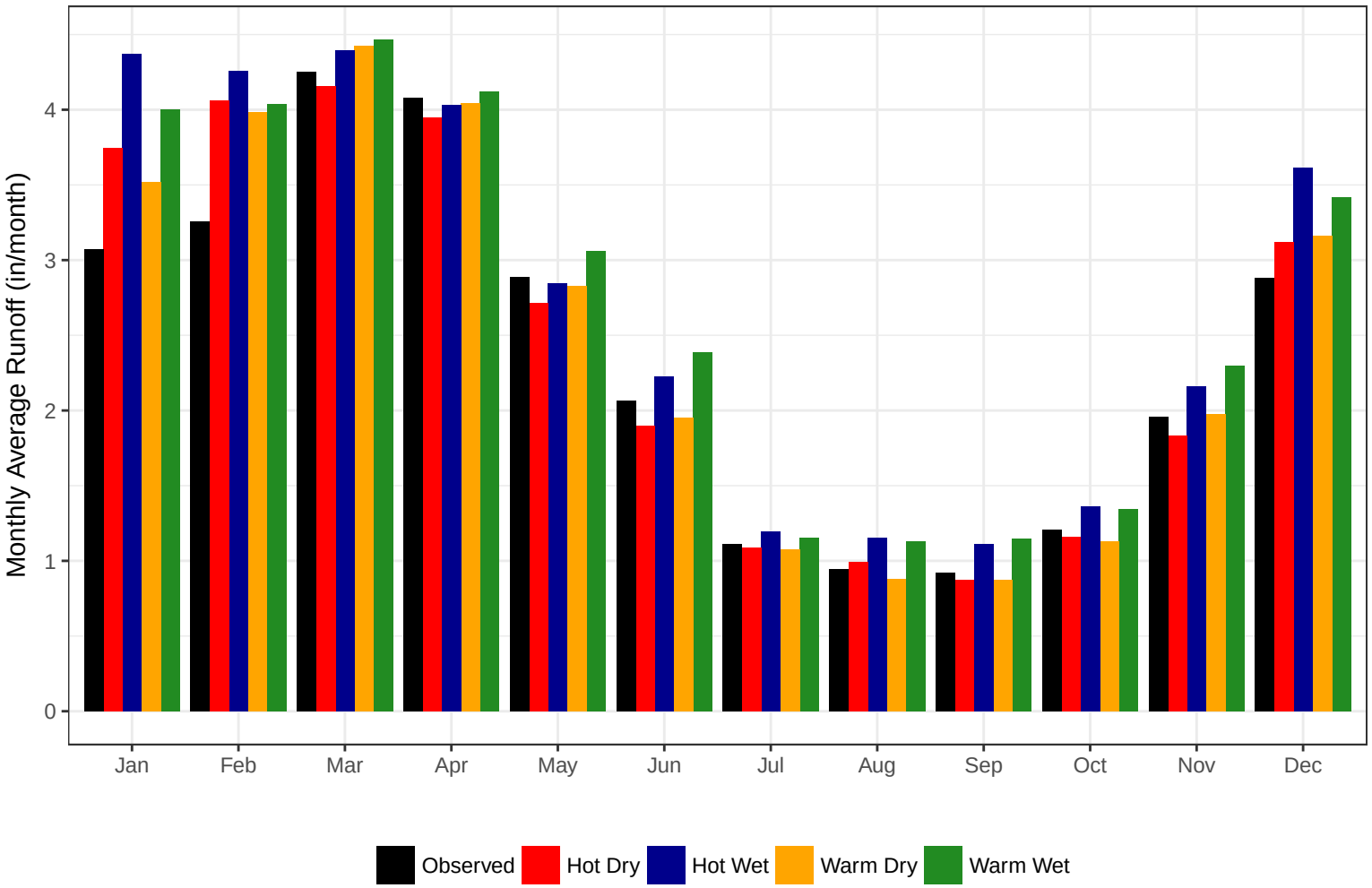
Reclamation (U.S. Bureau of Reclamation). 2010. Climate Change and Hydrology Scenarios for Oklahoma Yield Studies. Technical Memorandum 86-68210-2010-01. U.S. Department of the Interior, Bureau of Reclamation.



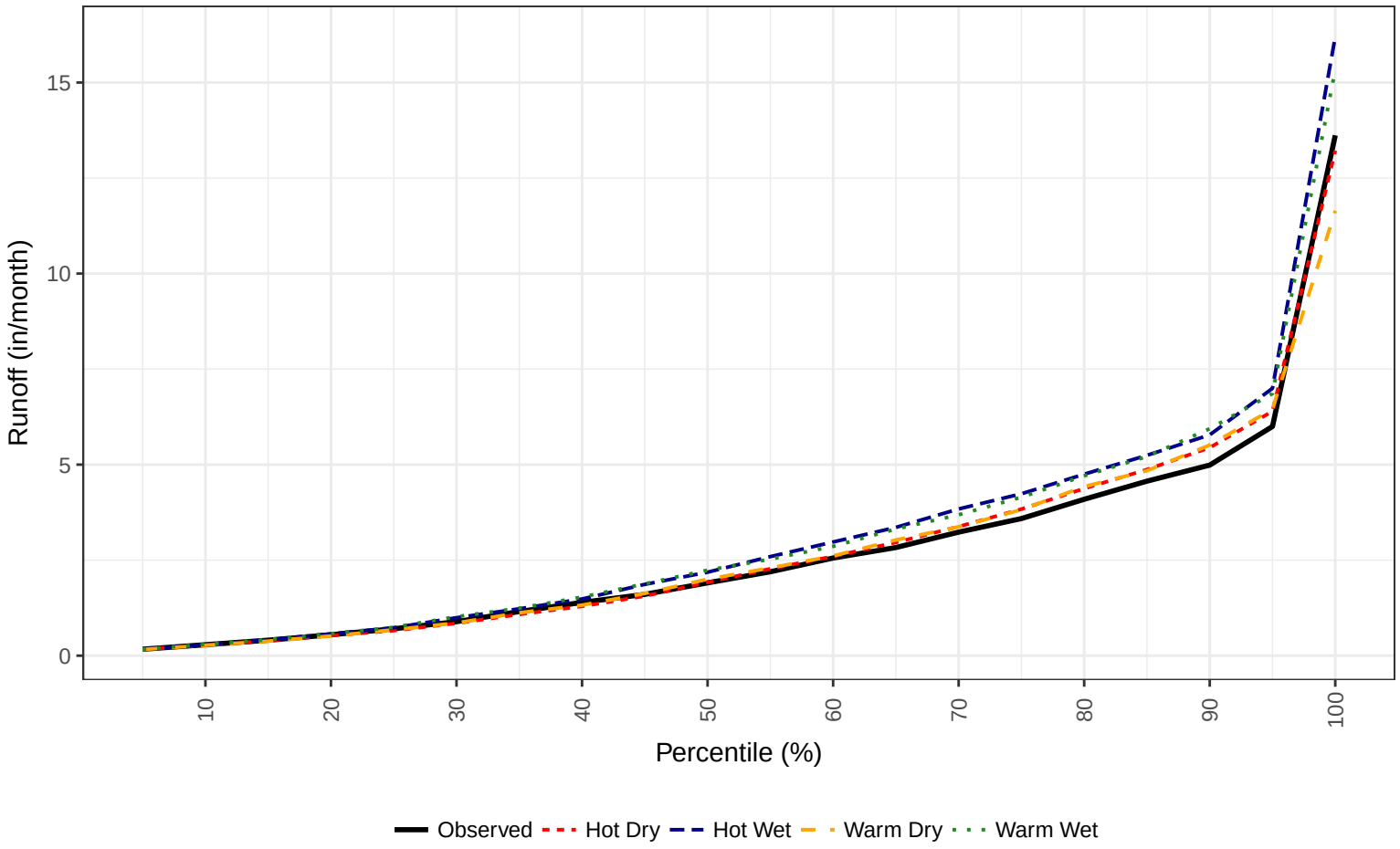


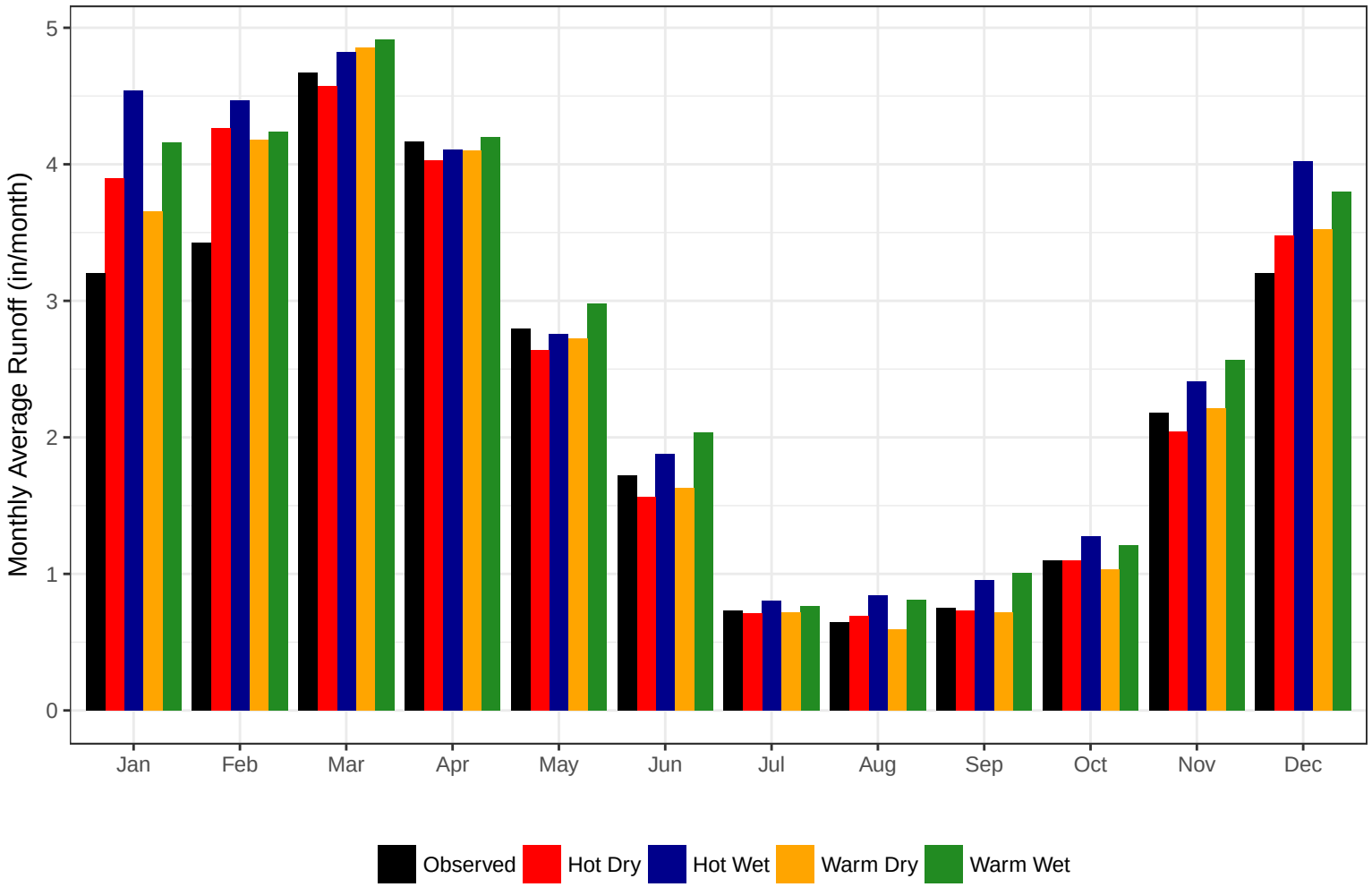
Climate Change Streamflow Projections for Pawcatuck Main Stem Regional Basin



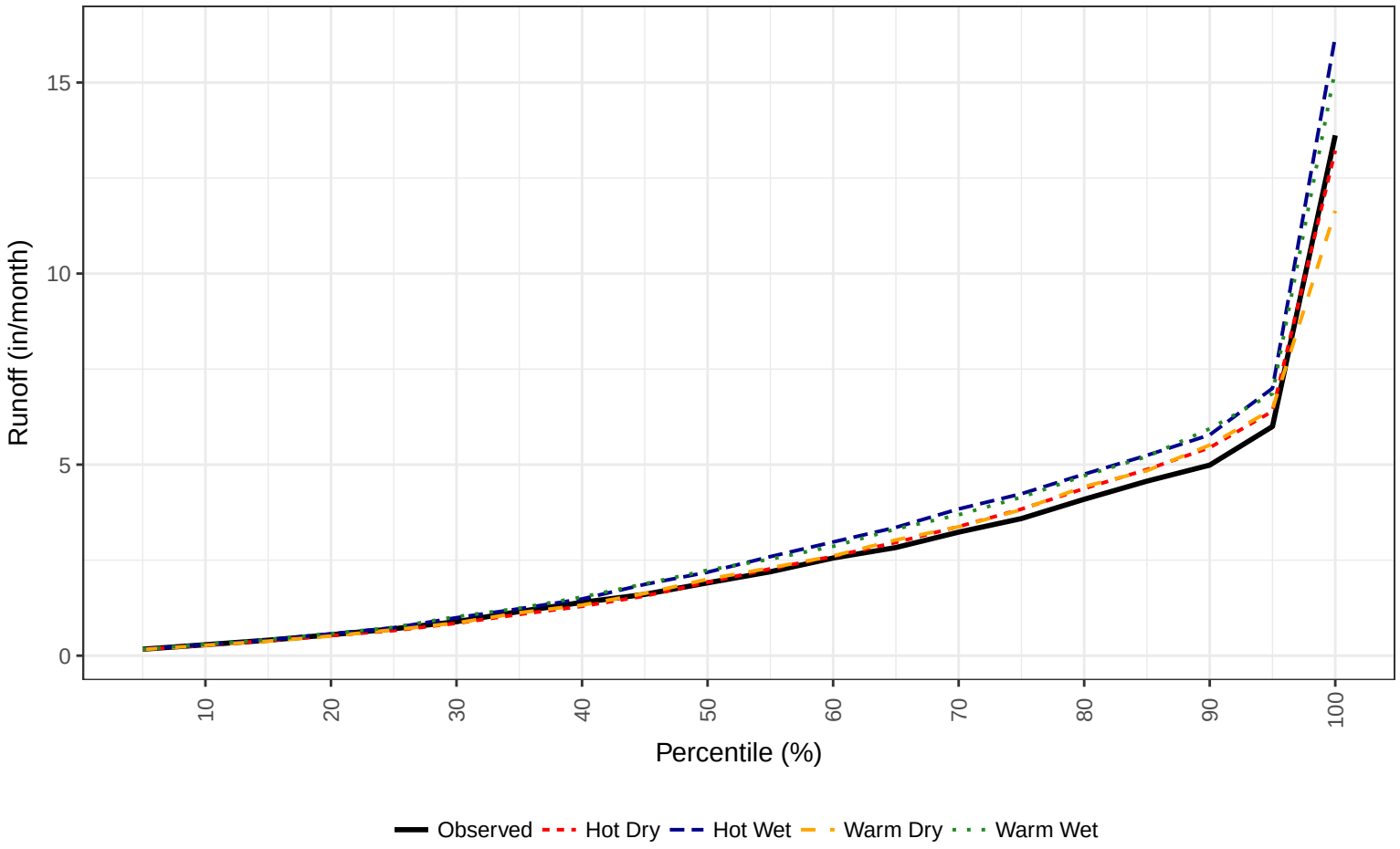


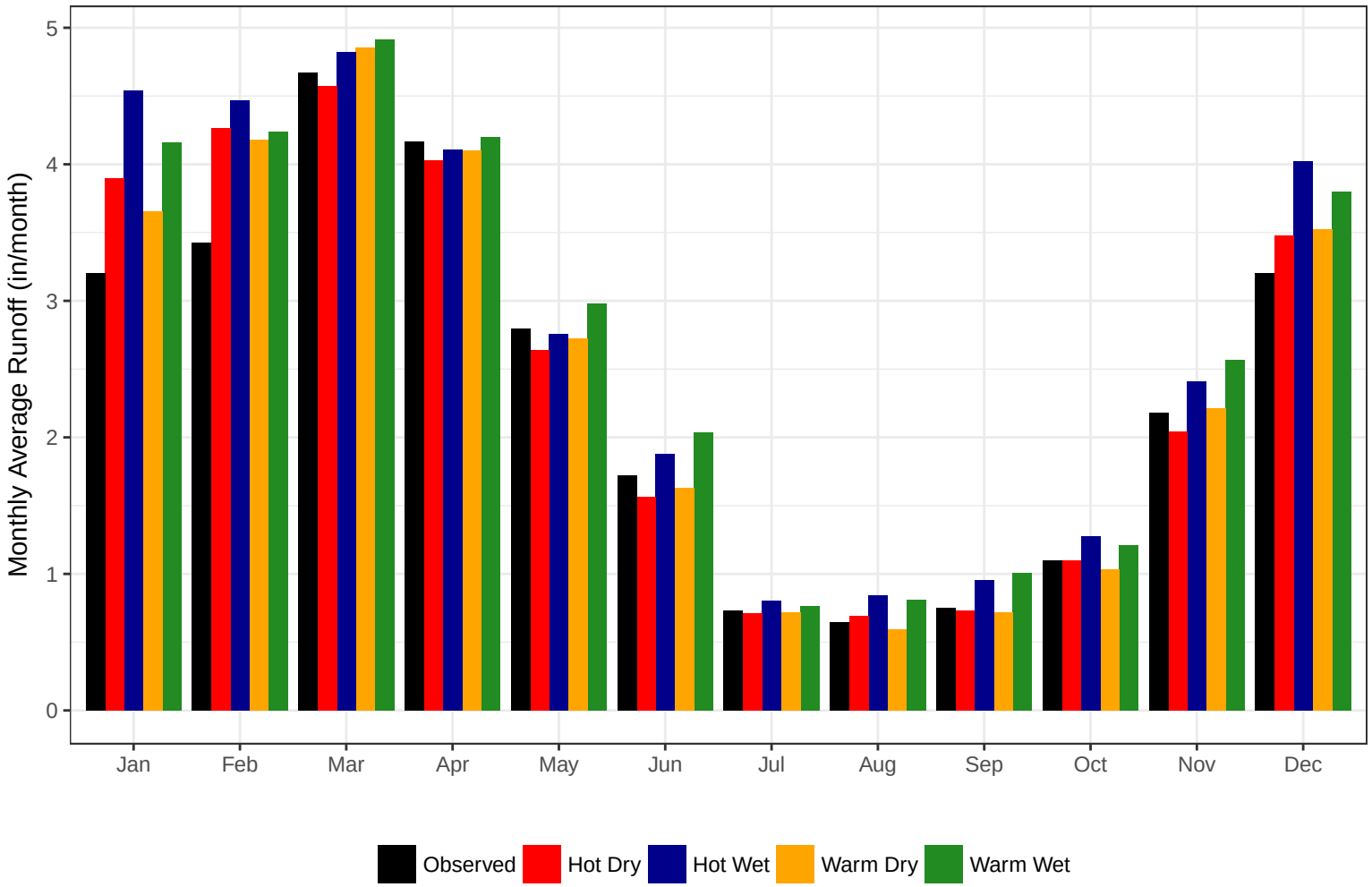
Climate Change Streamflow Projections for Wood Regional Basin



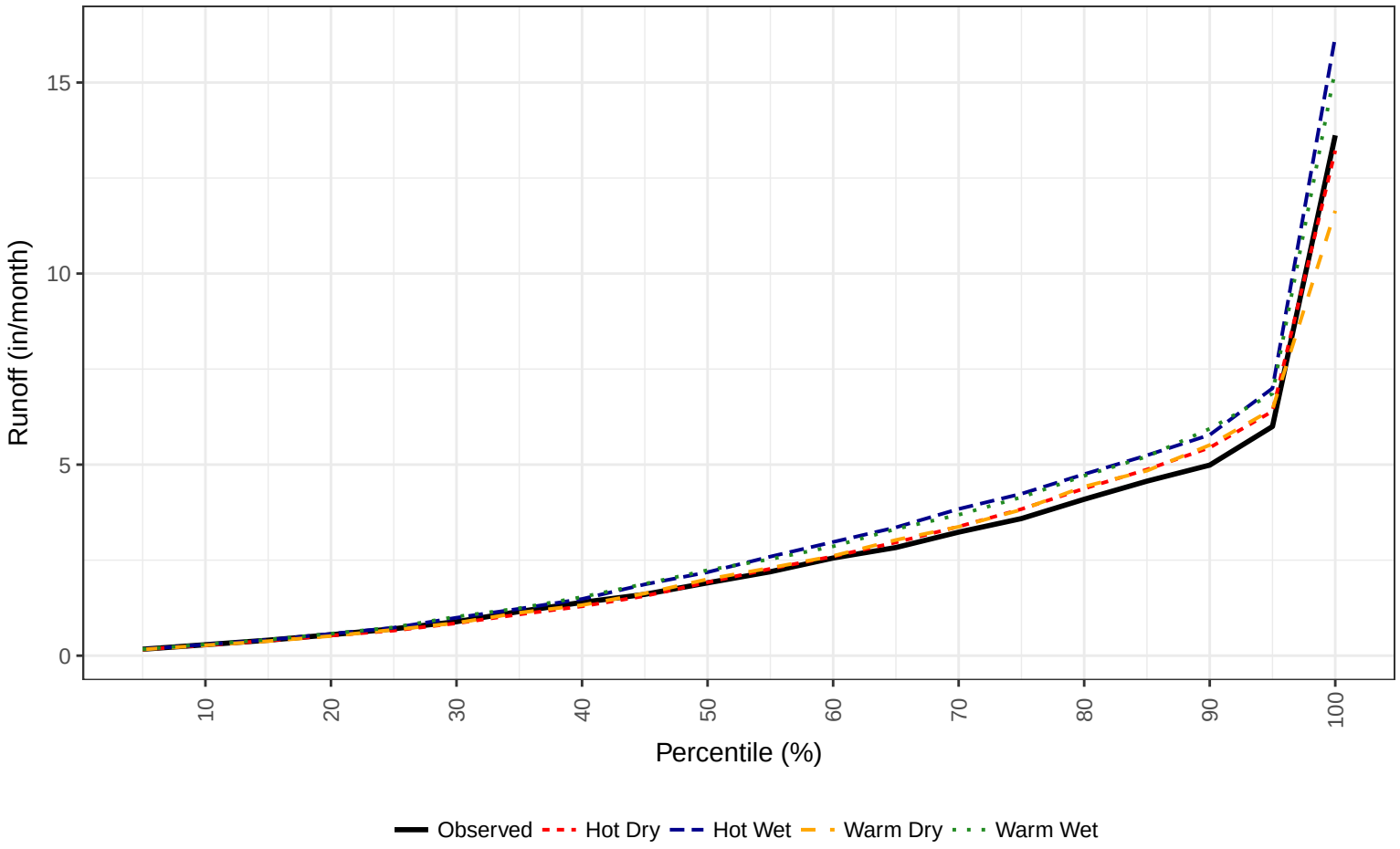


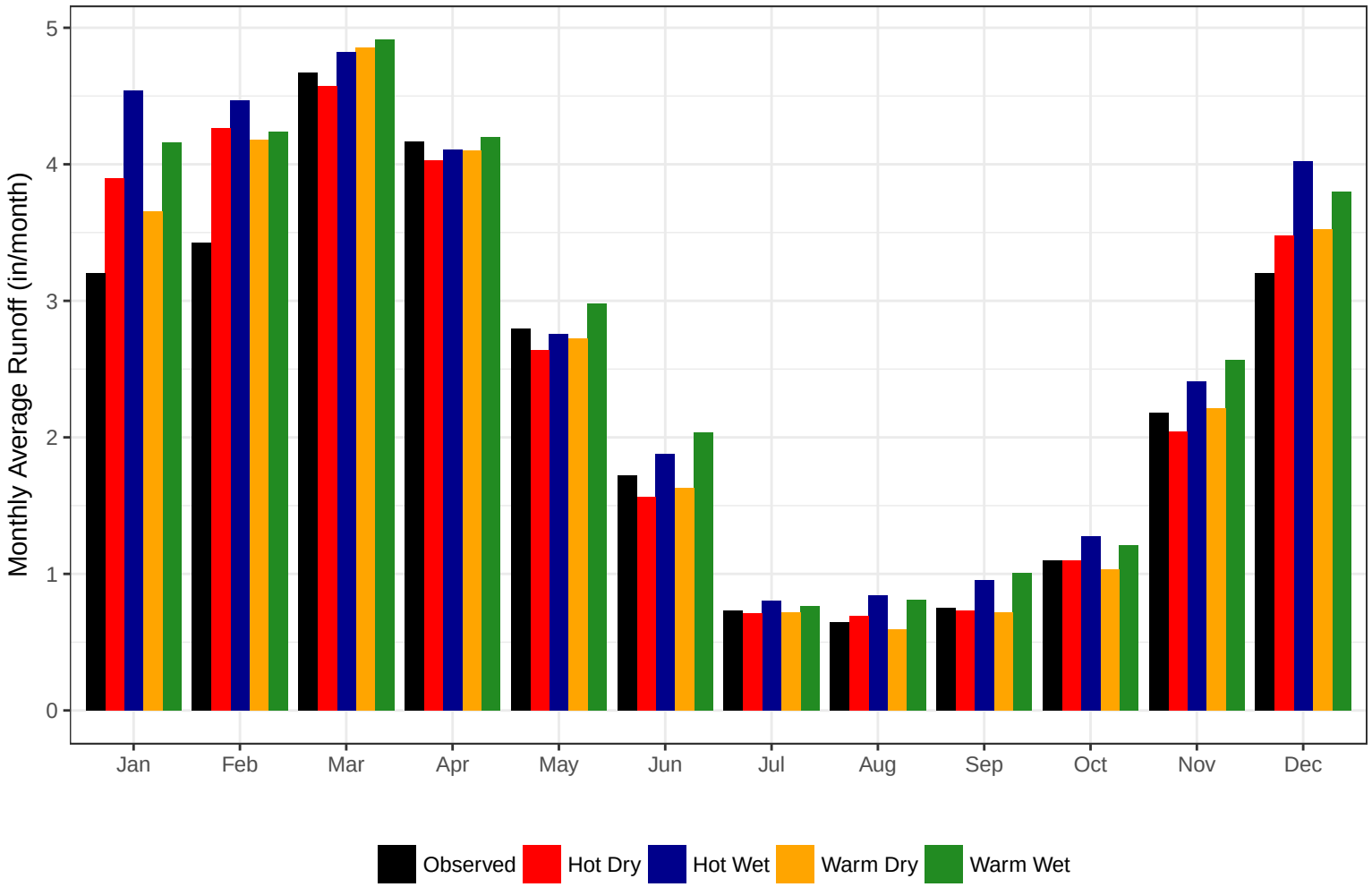
Climate Change Streamflow Projections for Southeast Shoreline Regional Basin



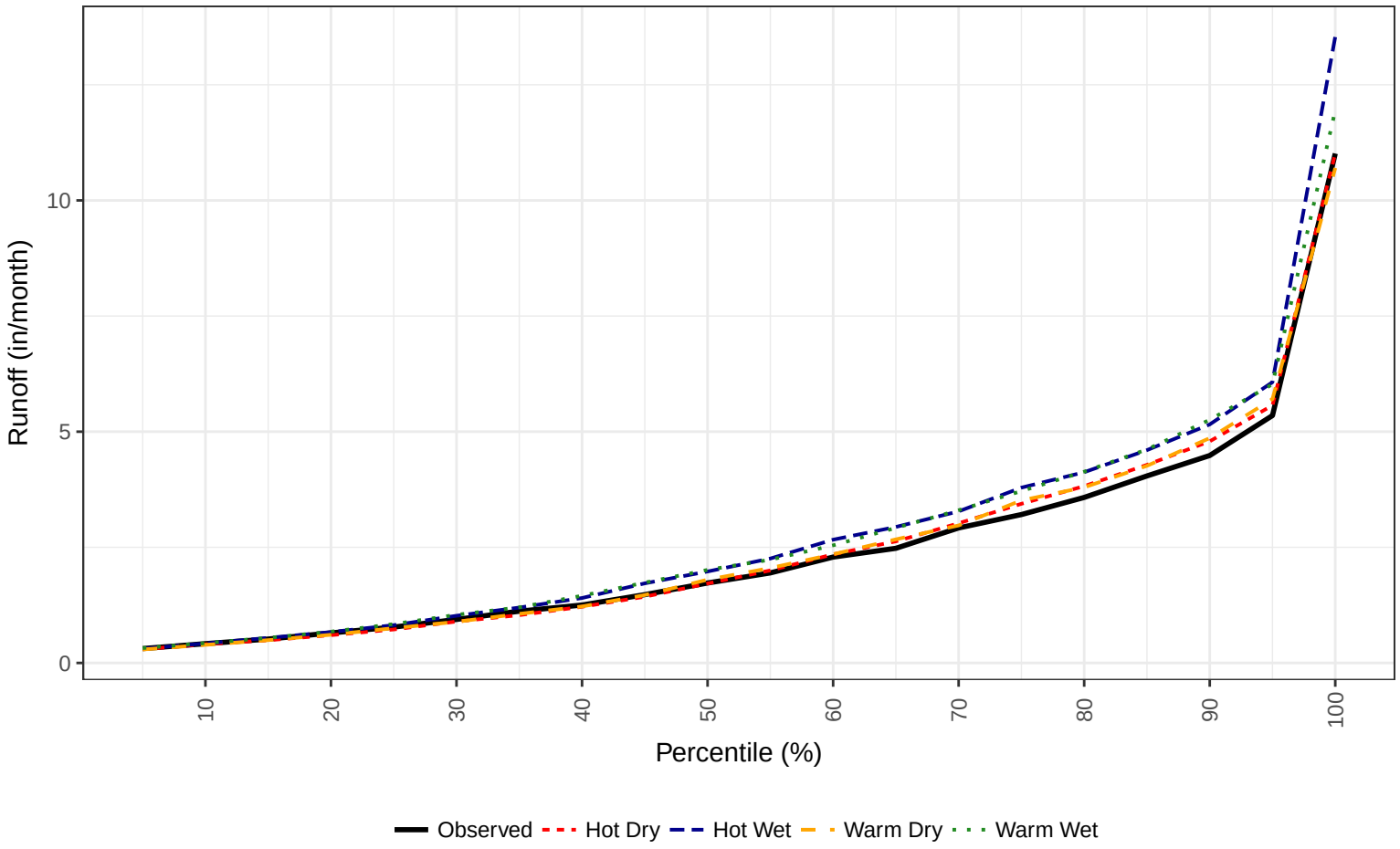


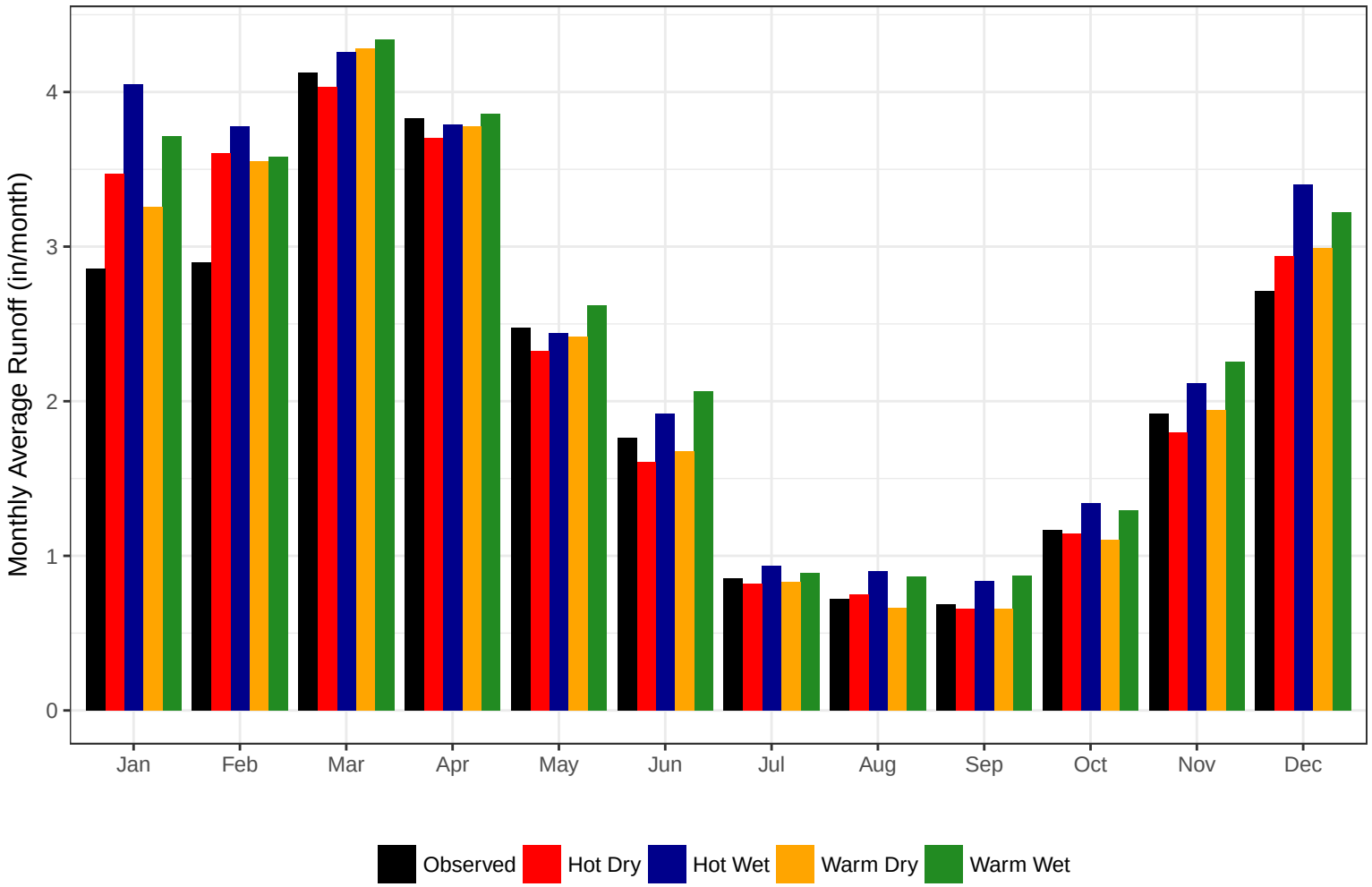
Climate Change Streamflow Projections for Southeast Eastern Complex Regional Basin



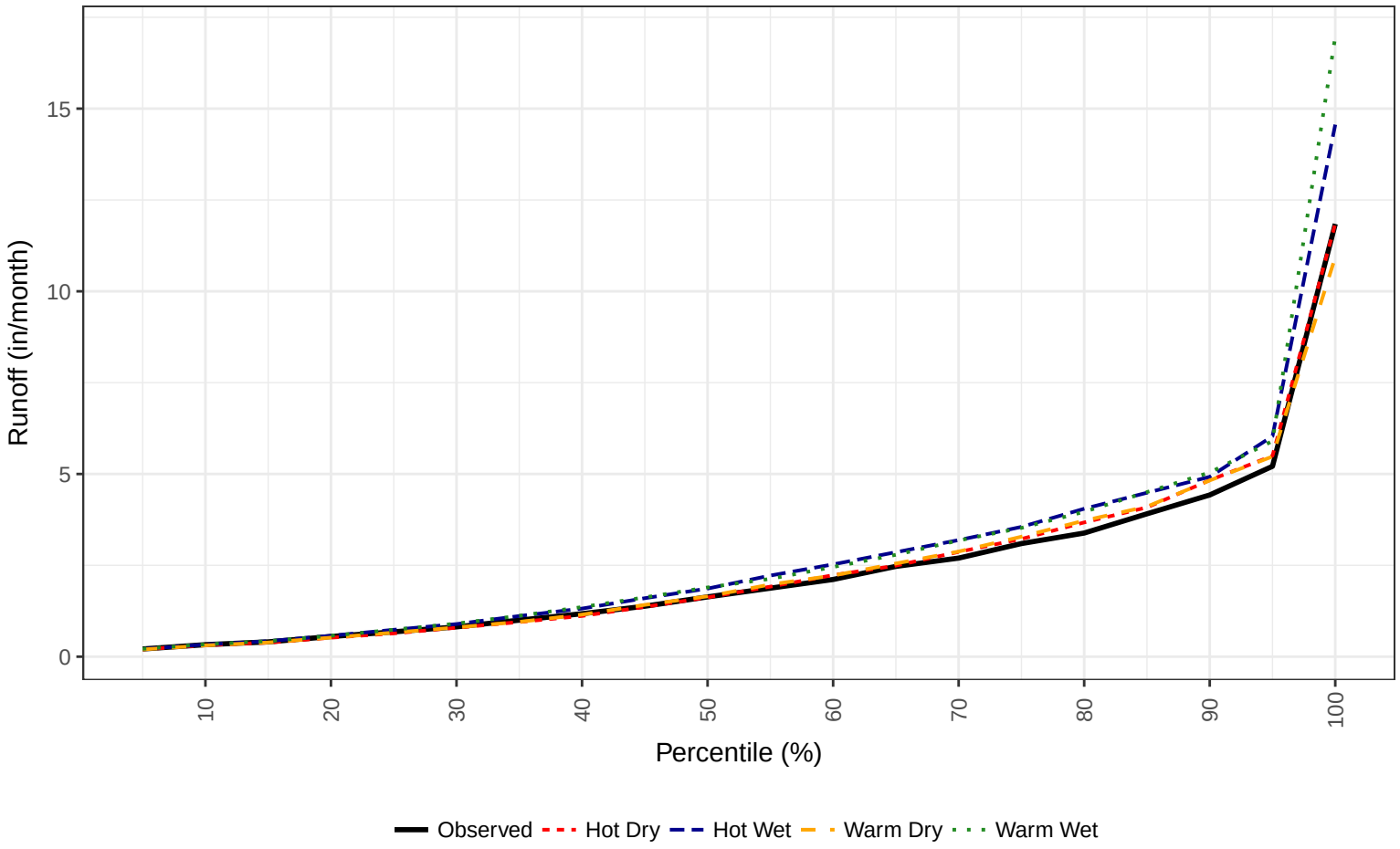


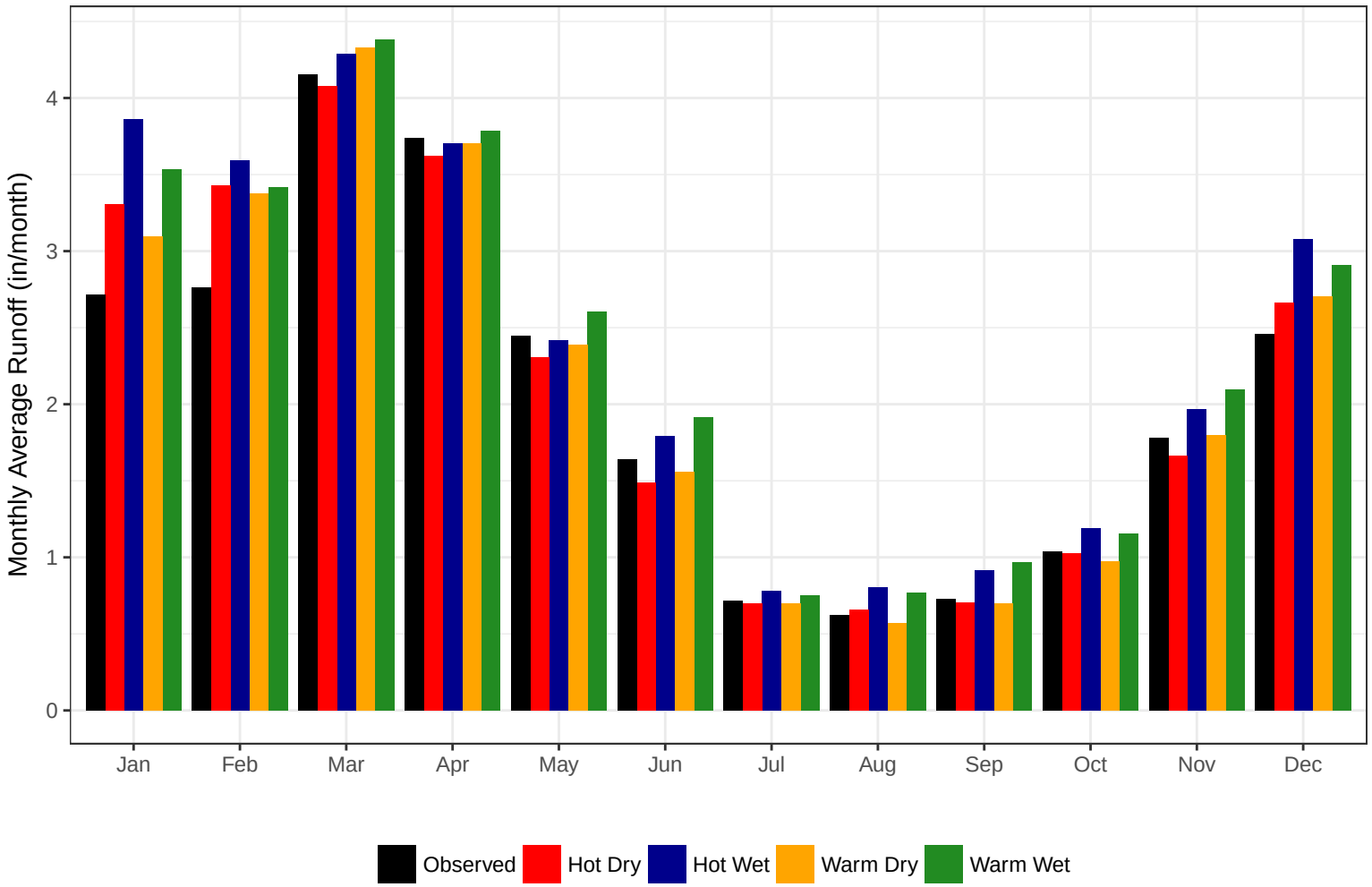
Climate Change Streamflow Projections for Southeast Western Complex Regional Basin



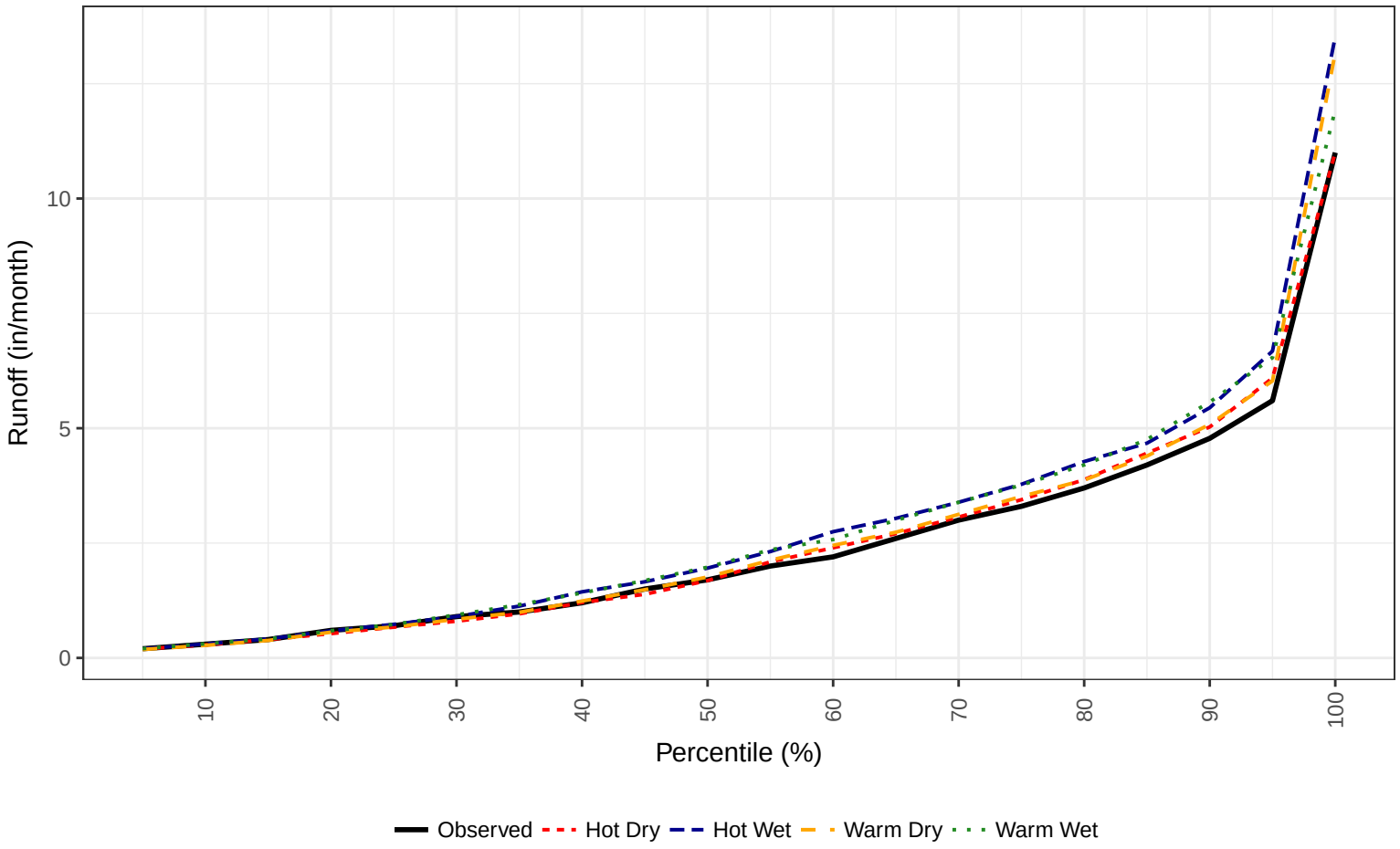


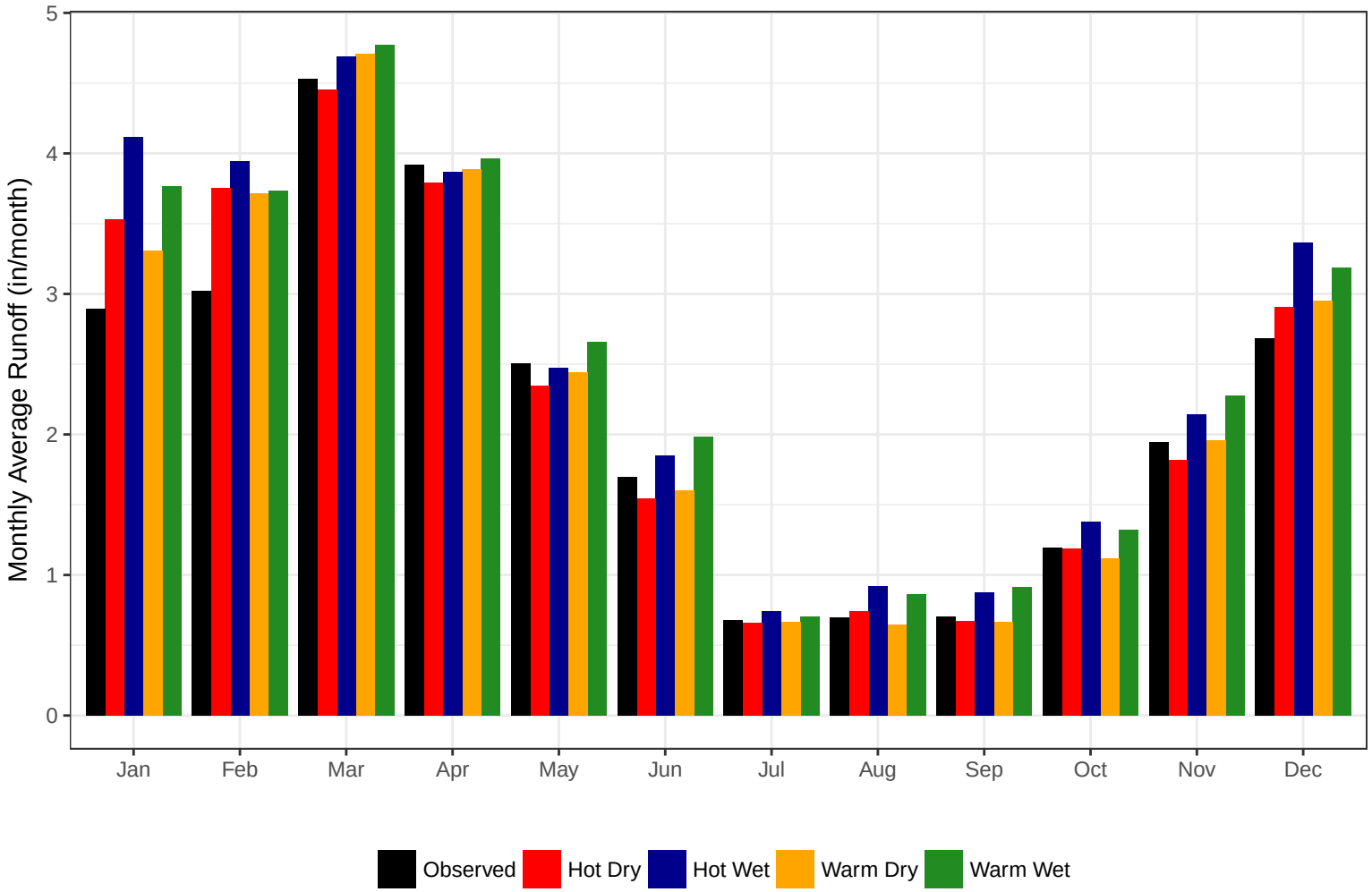
Climate Change Streamflow Projections for Thames Main Stem Regional Basin



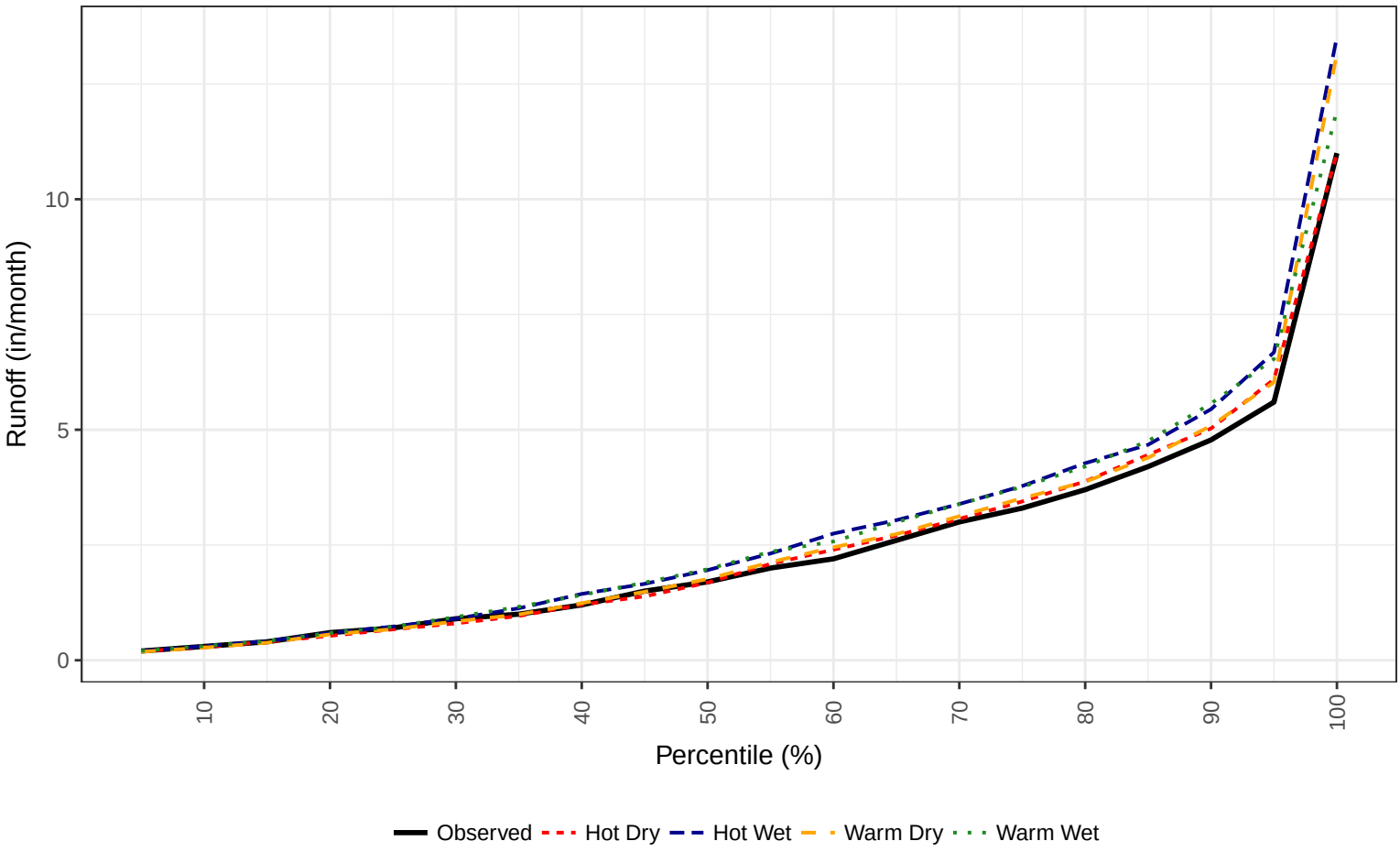


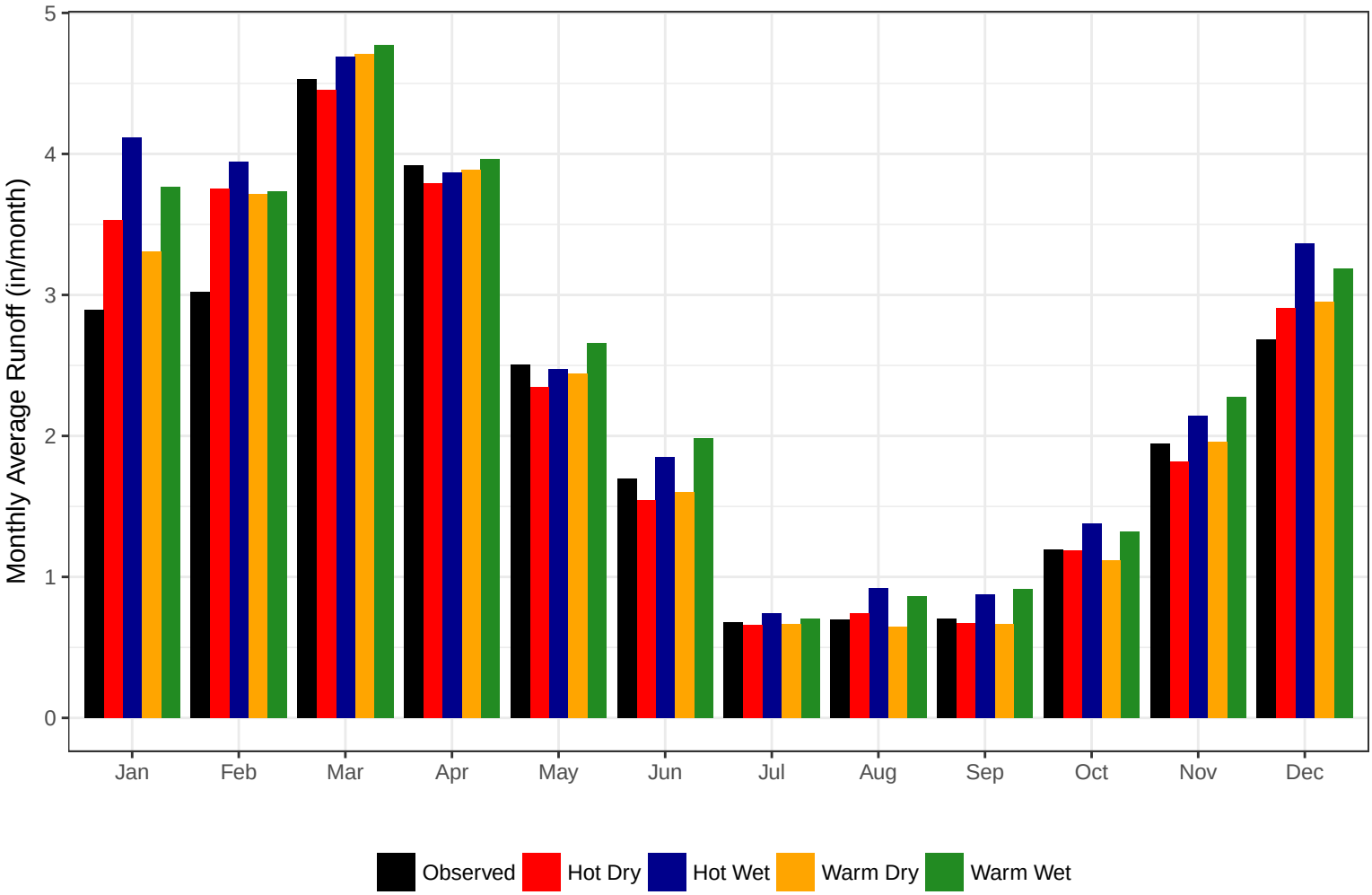
Climate Change Streamflow Projections for Willimantic Regional Basin



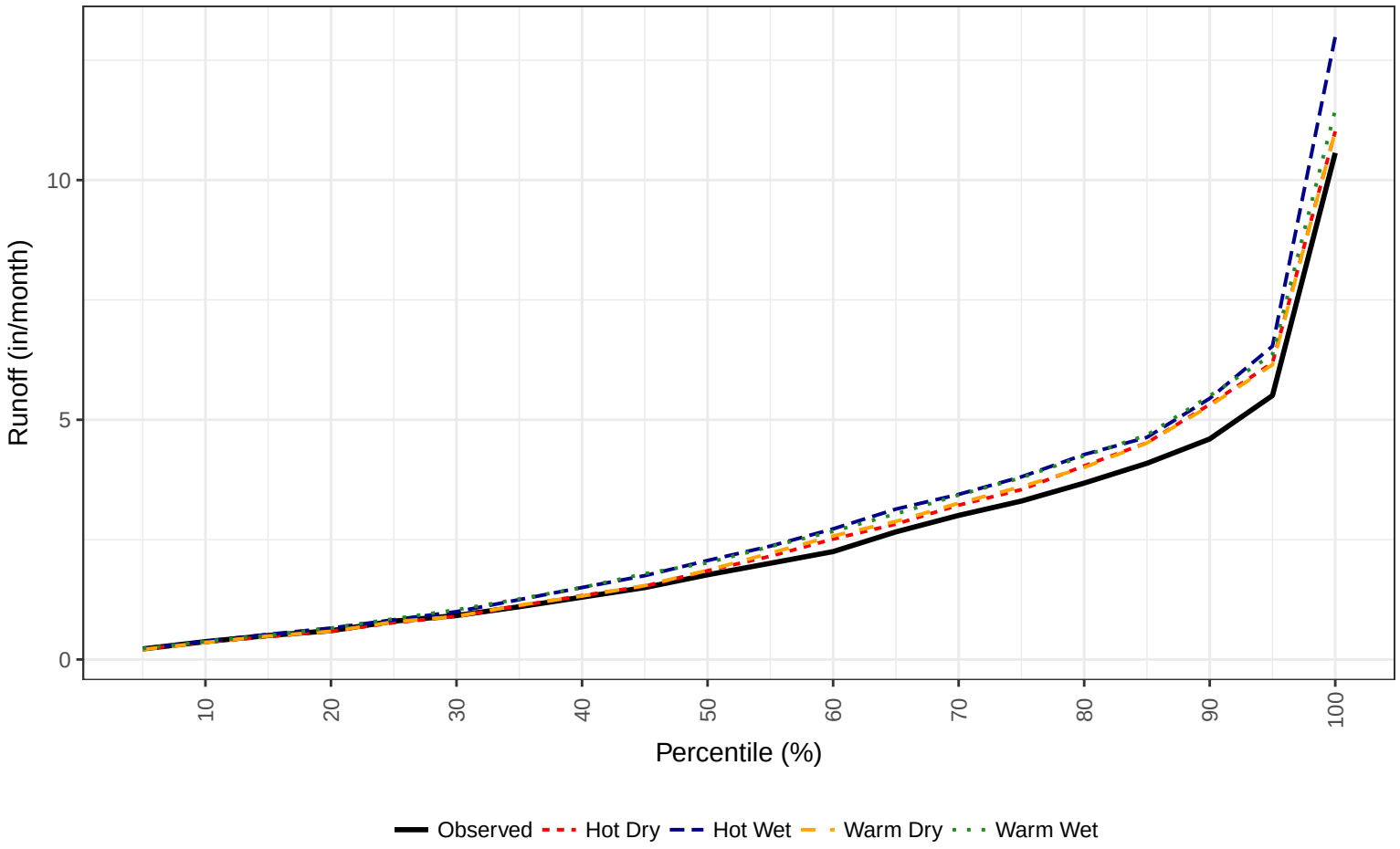


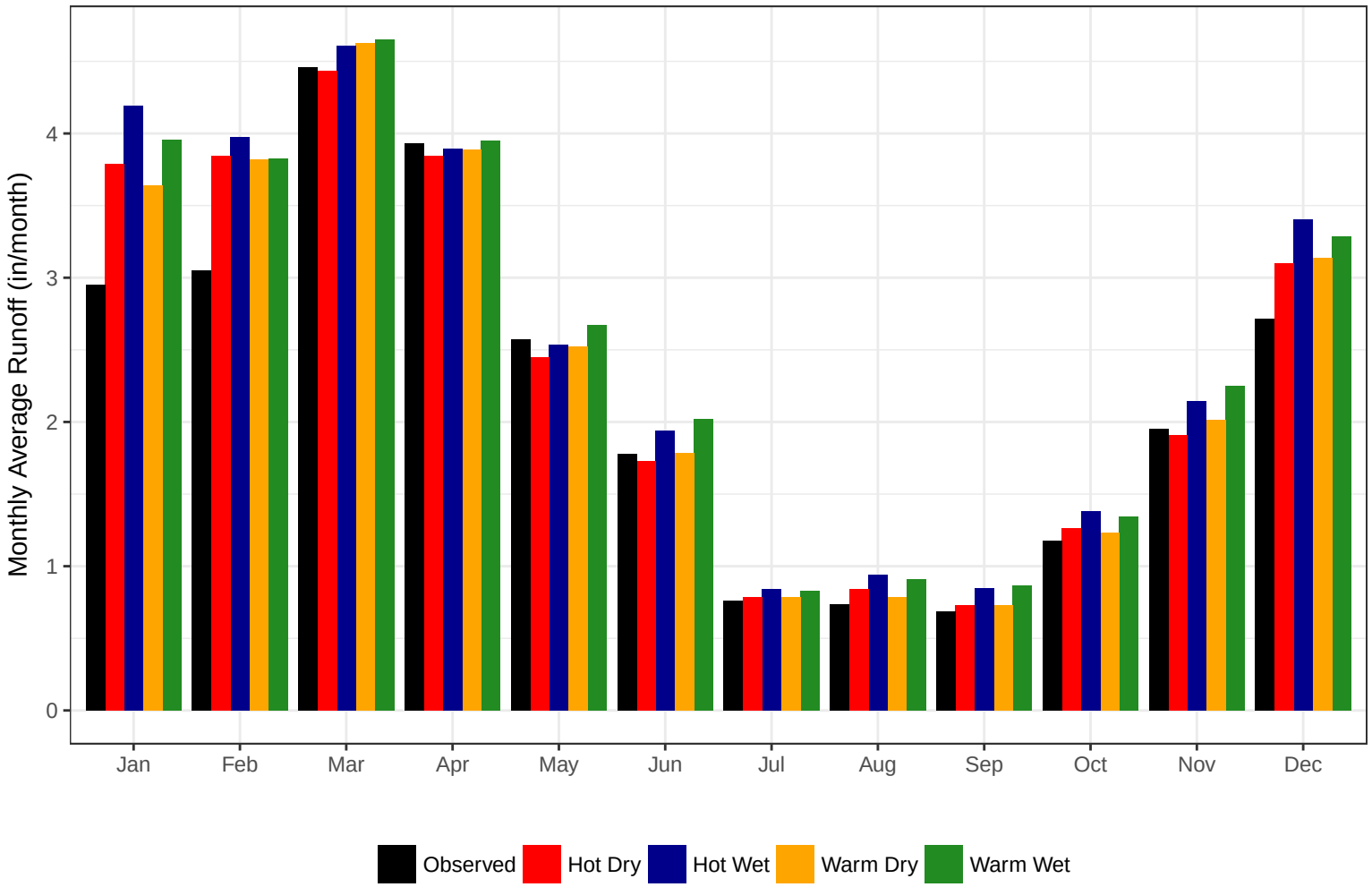
Climate Change Streamflow Projections for Natchaug Regional Basin



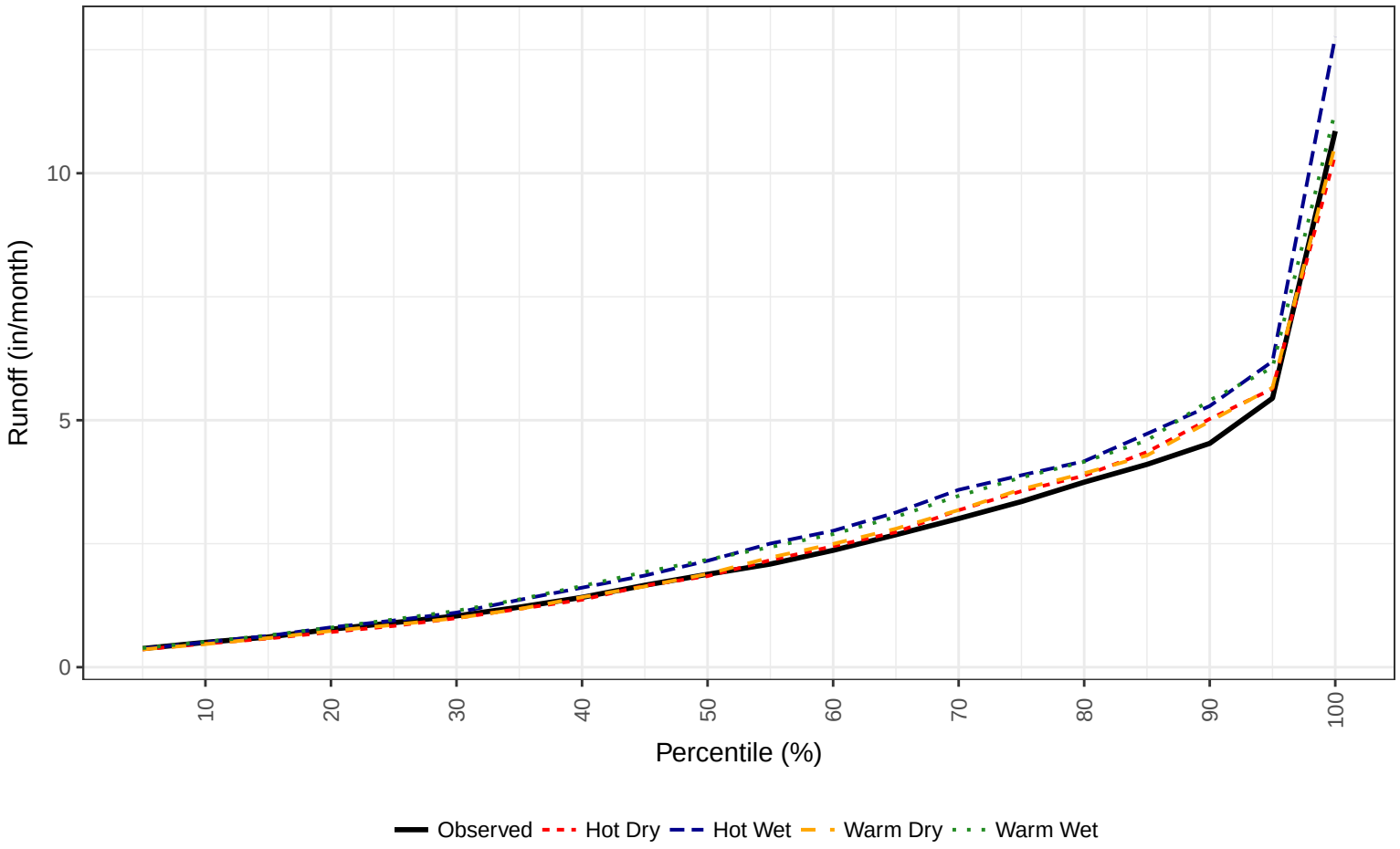


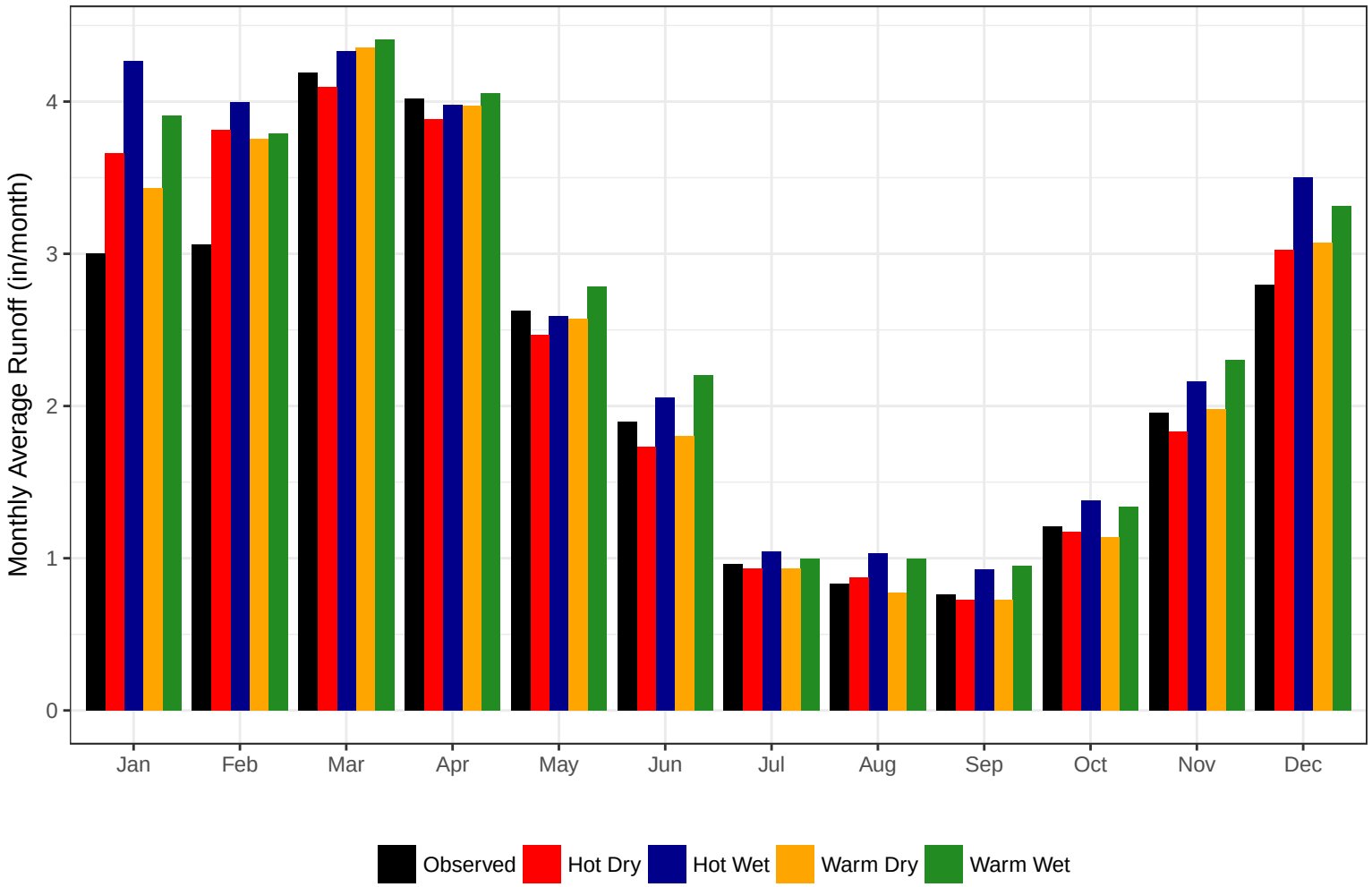
Climate Change Streamflow Projections for French Regional Basin



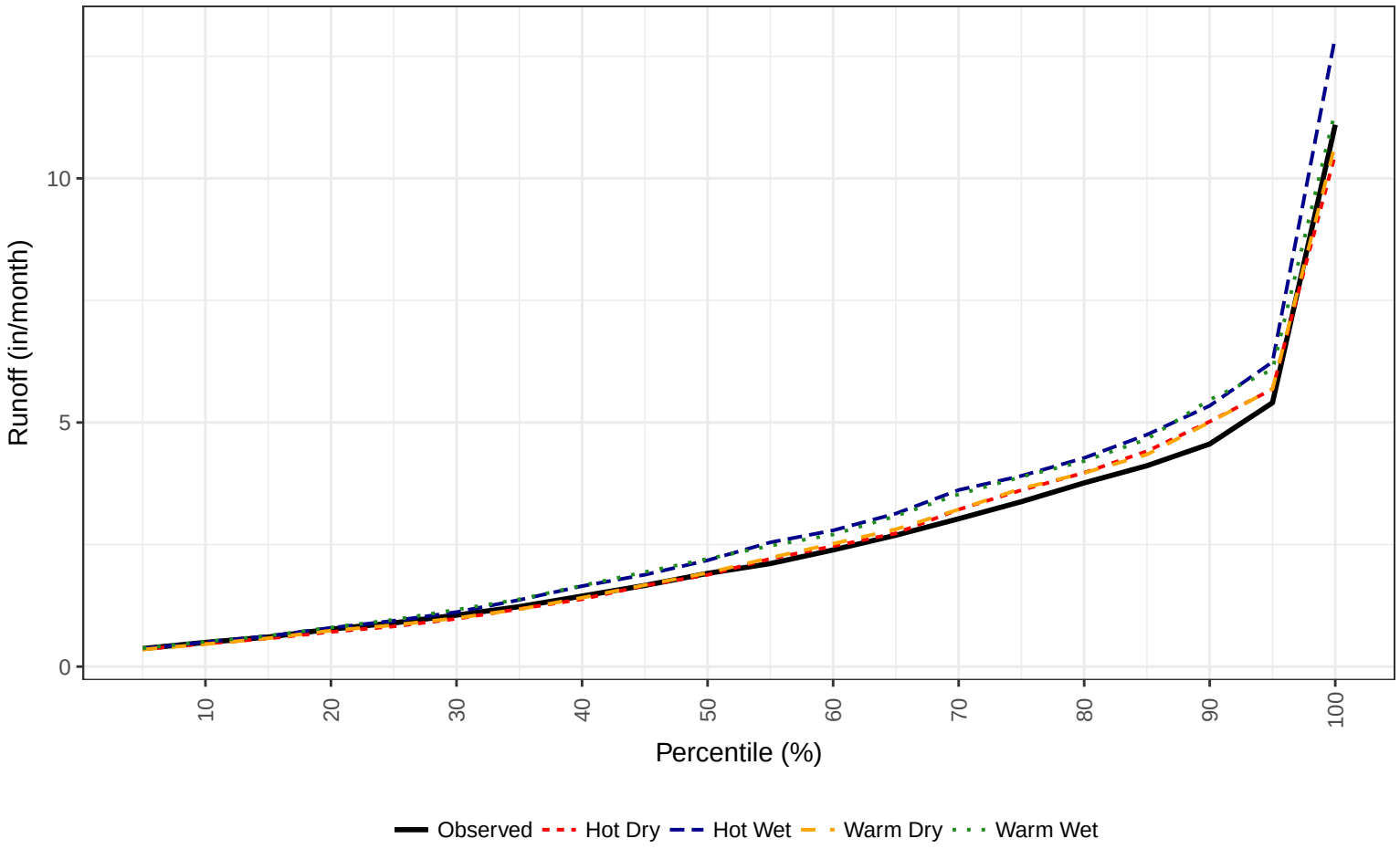


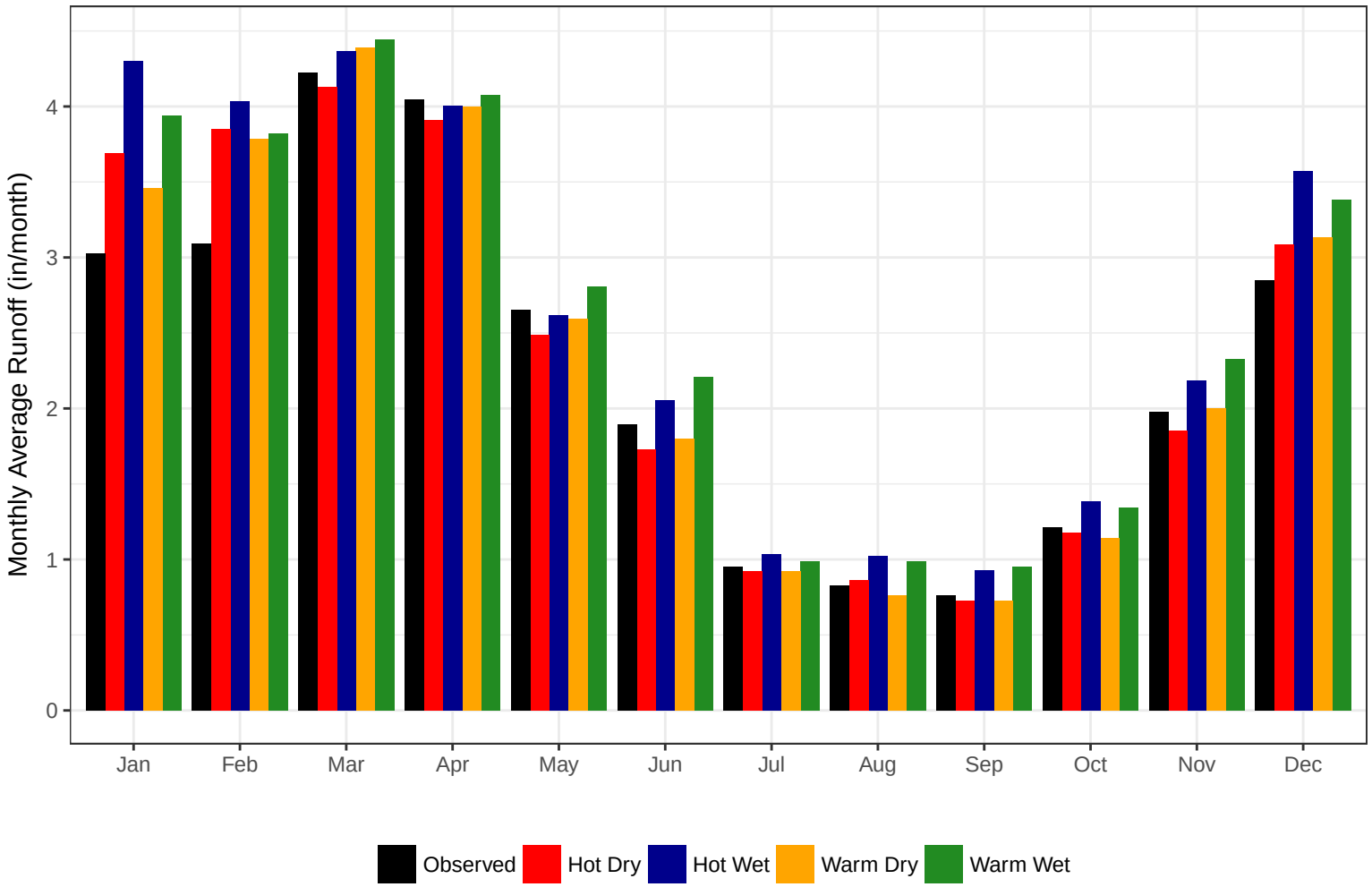
Climate Change Streamflow Projections for Fivemile Regional Basin



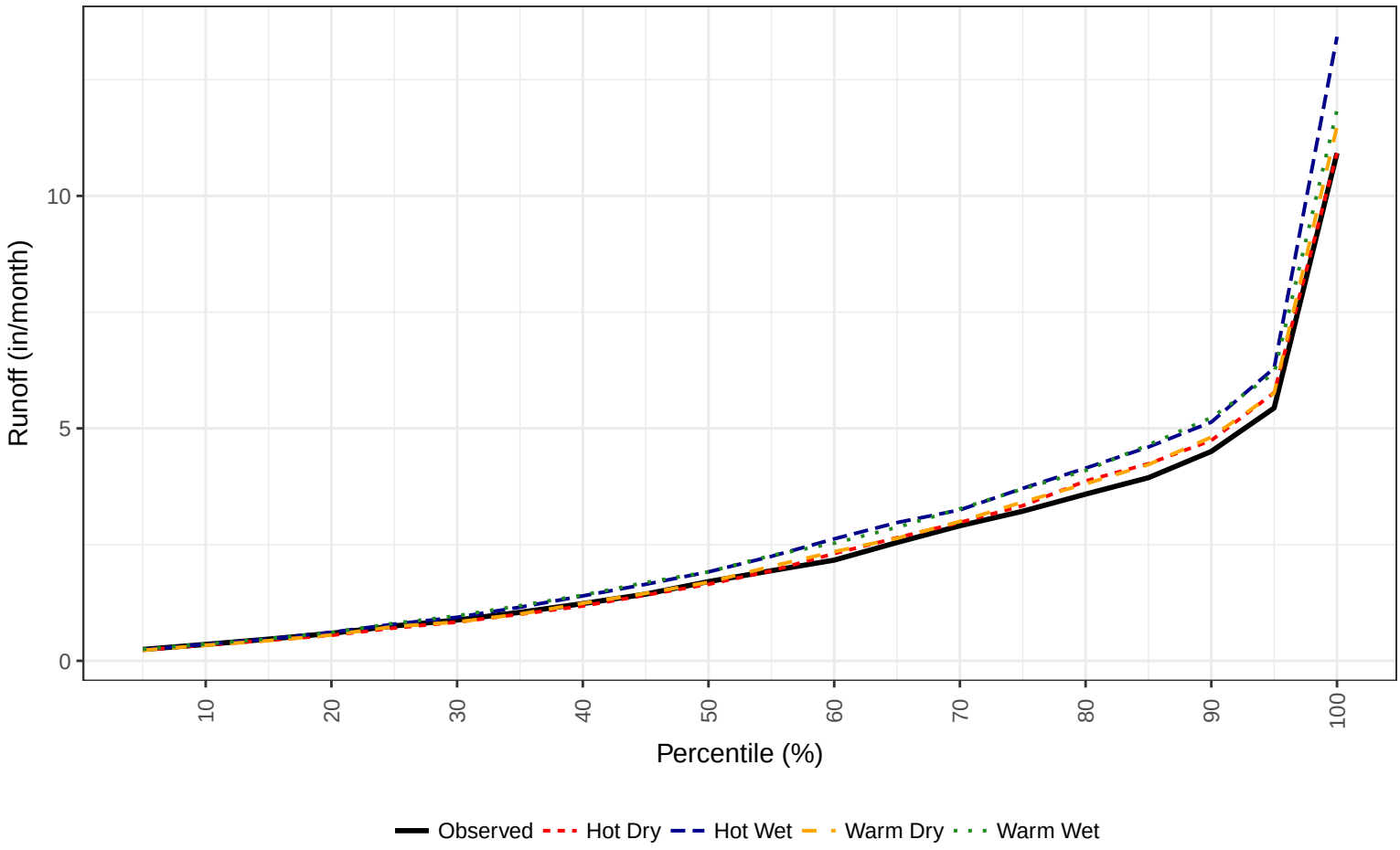


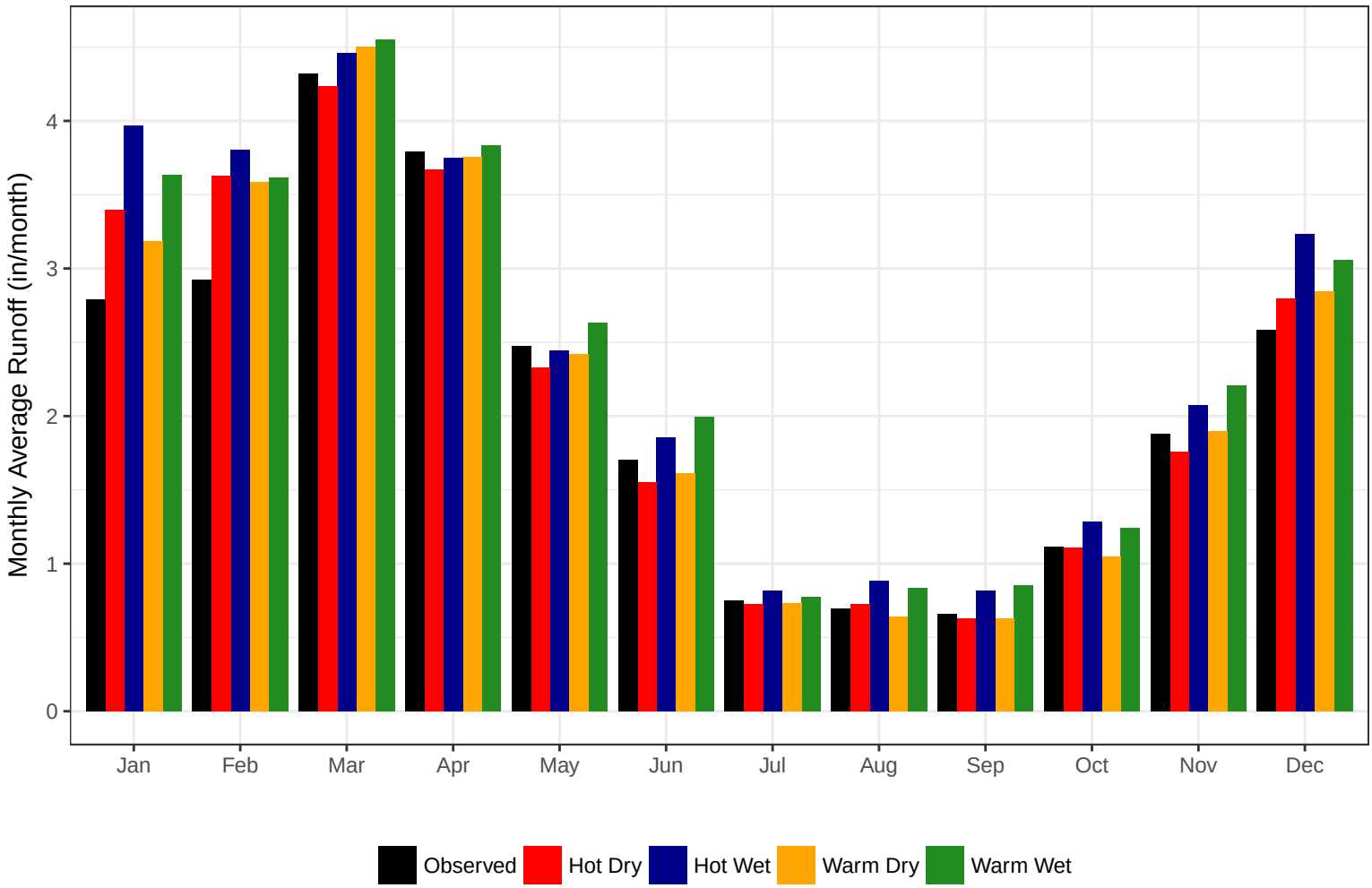
Climate Change Streamflow Projections for Moosup Regional Basin



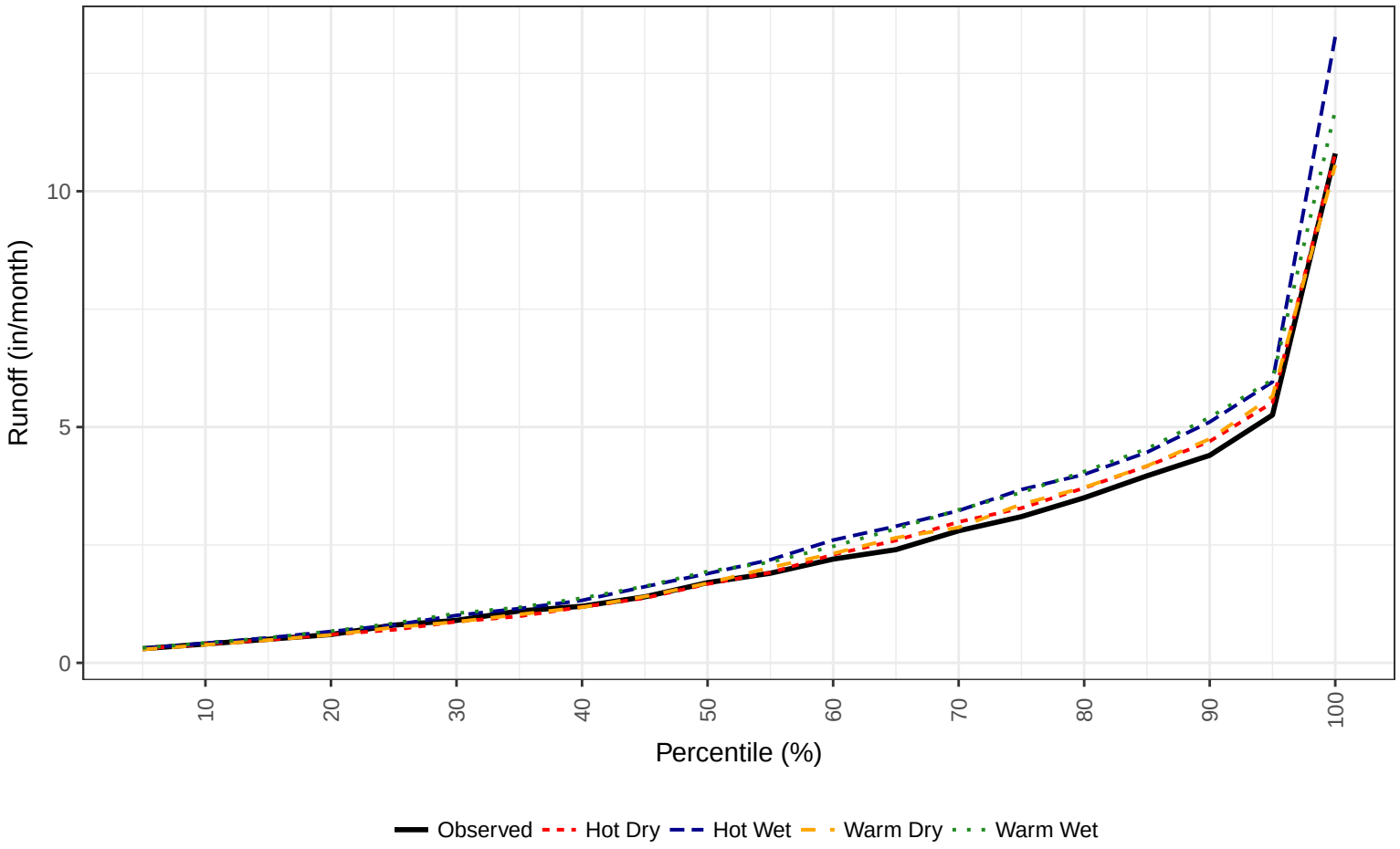


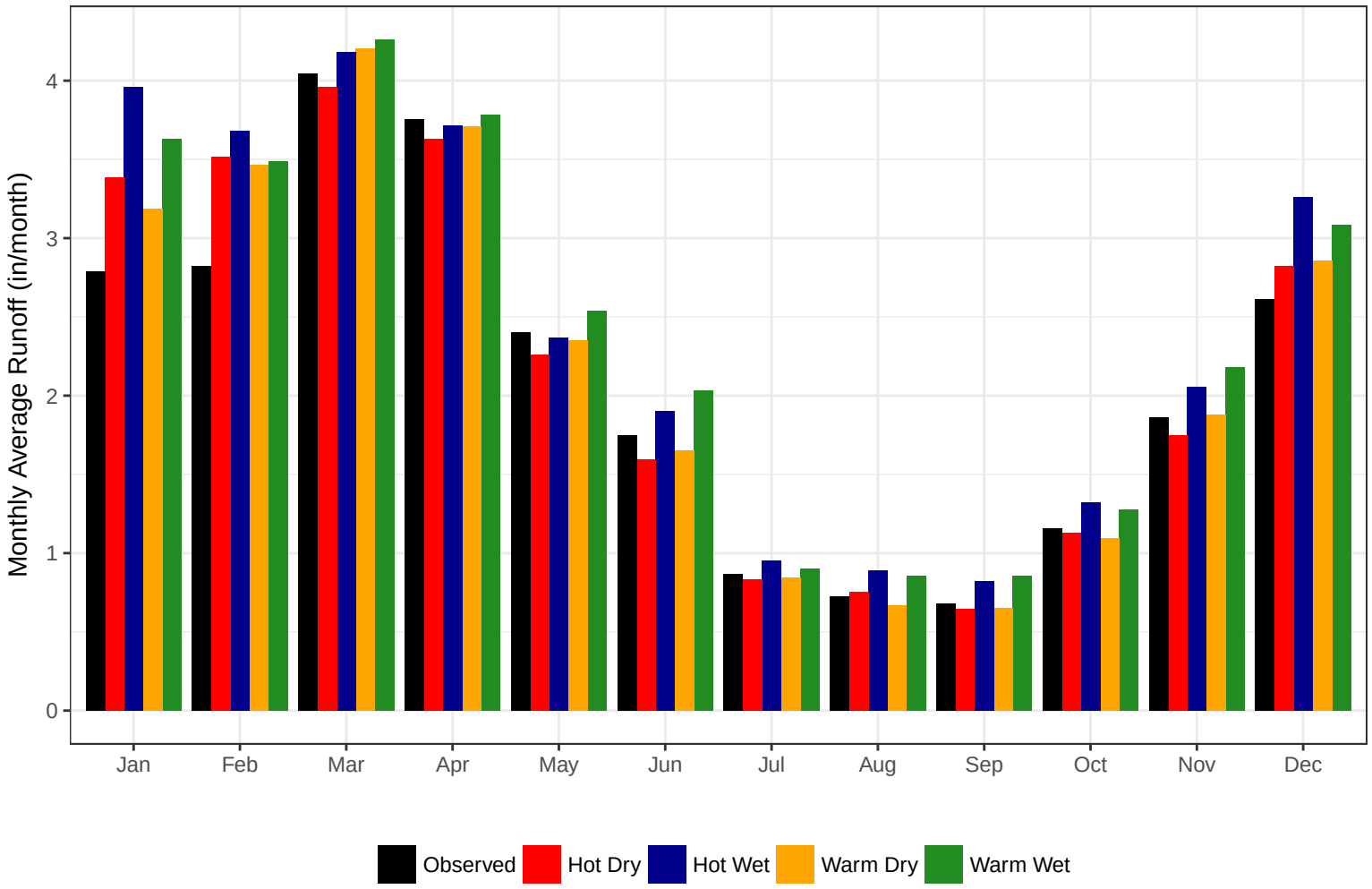
Climate Change Streamflow Projections for Pachaug Regional Basin



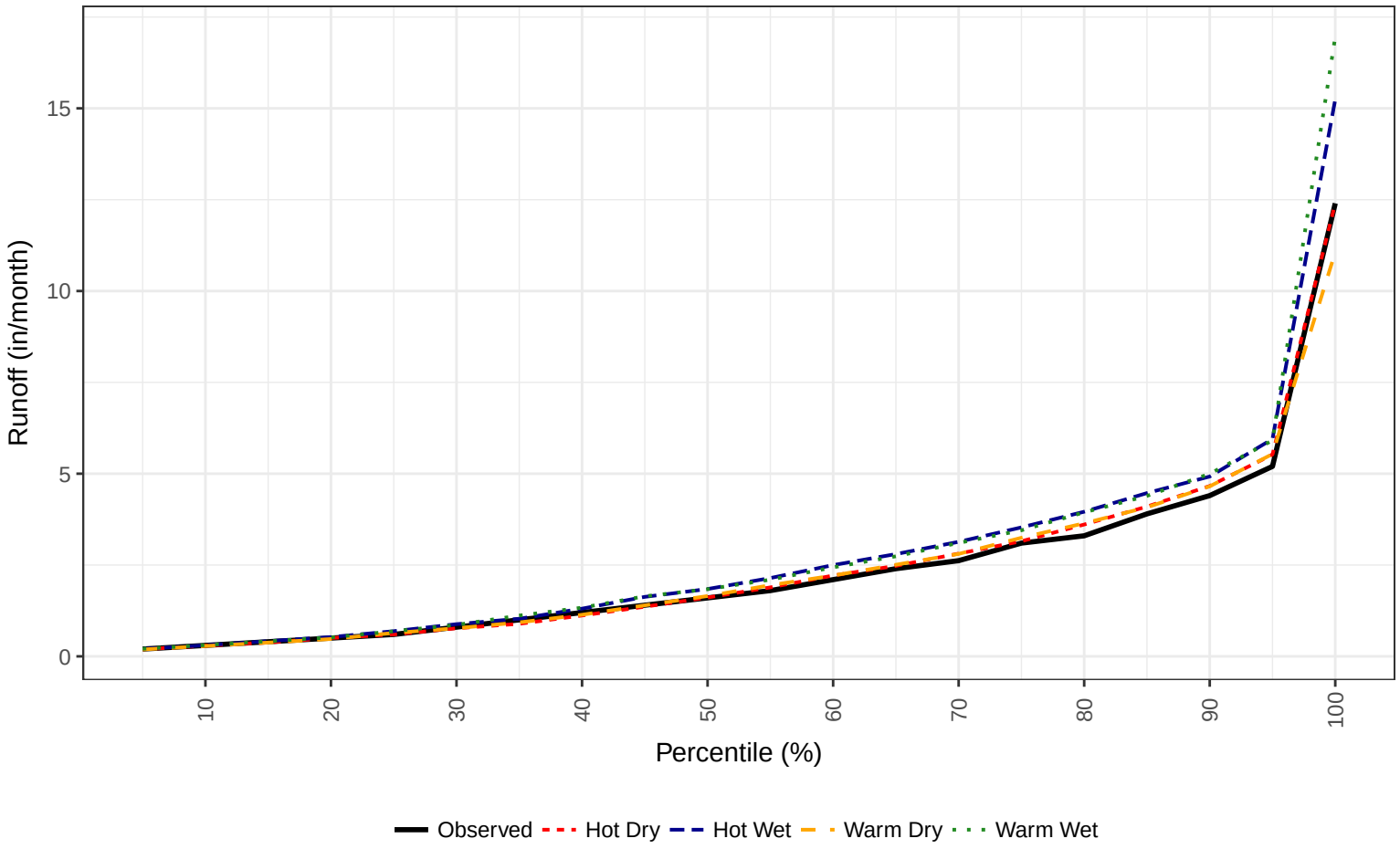


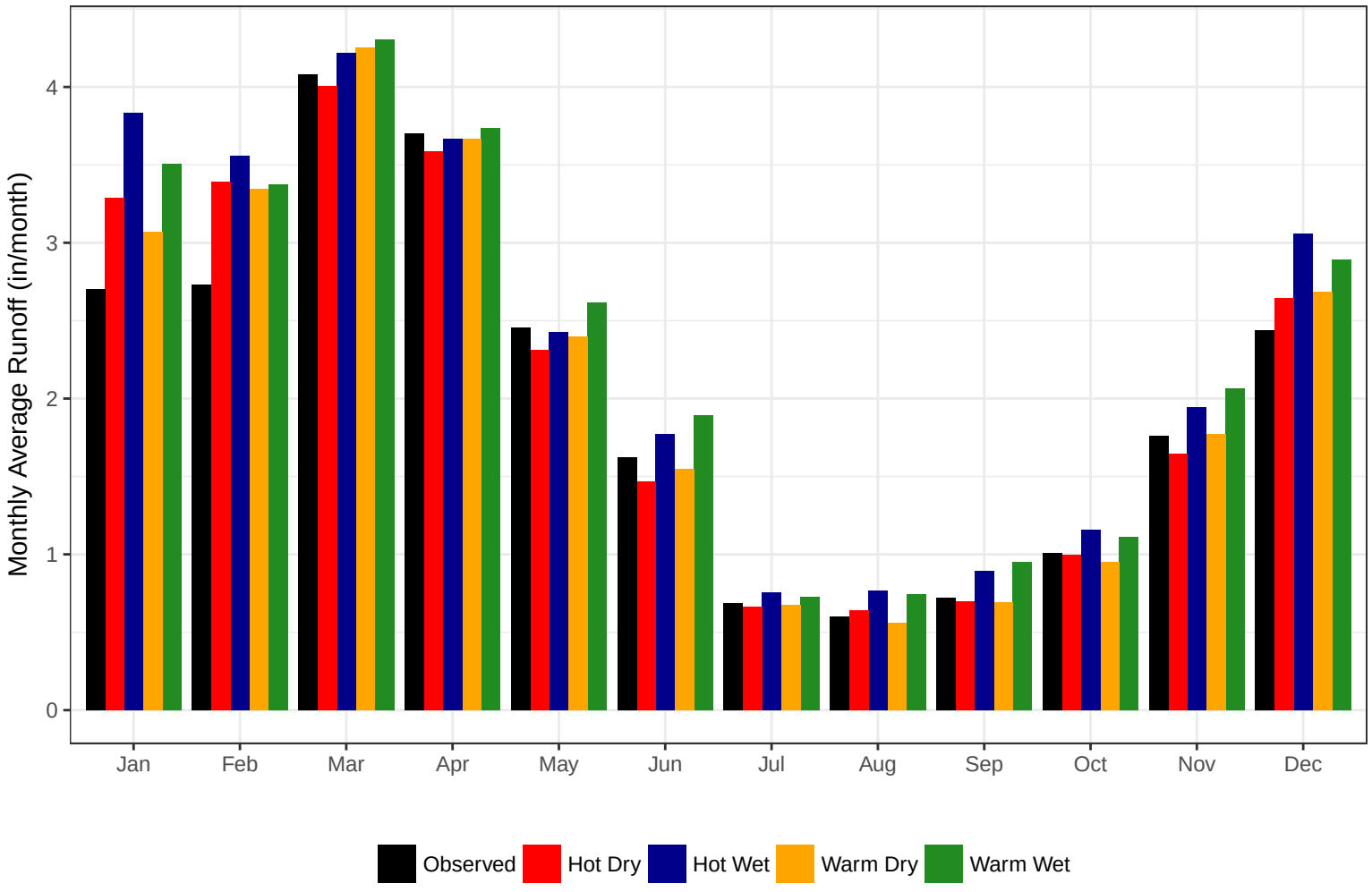
Climate Change Streamflow Projections for Quinebaug Regional Basin



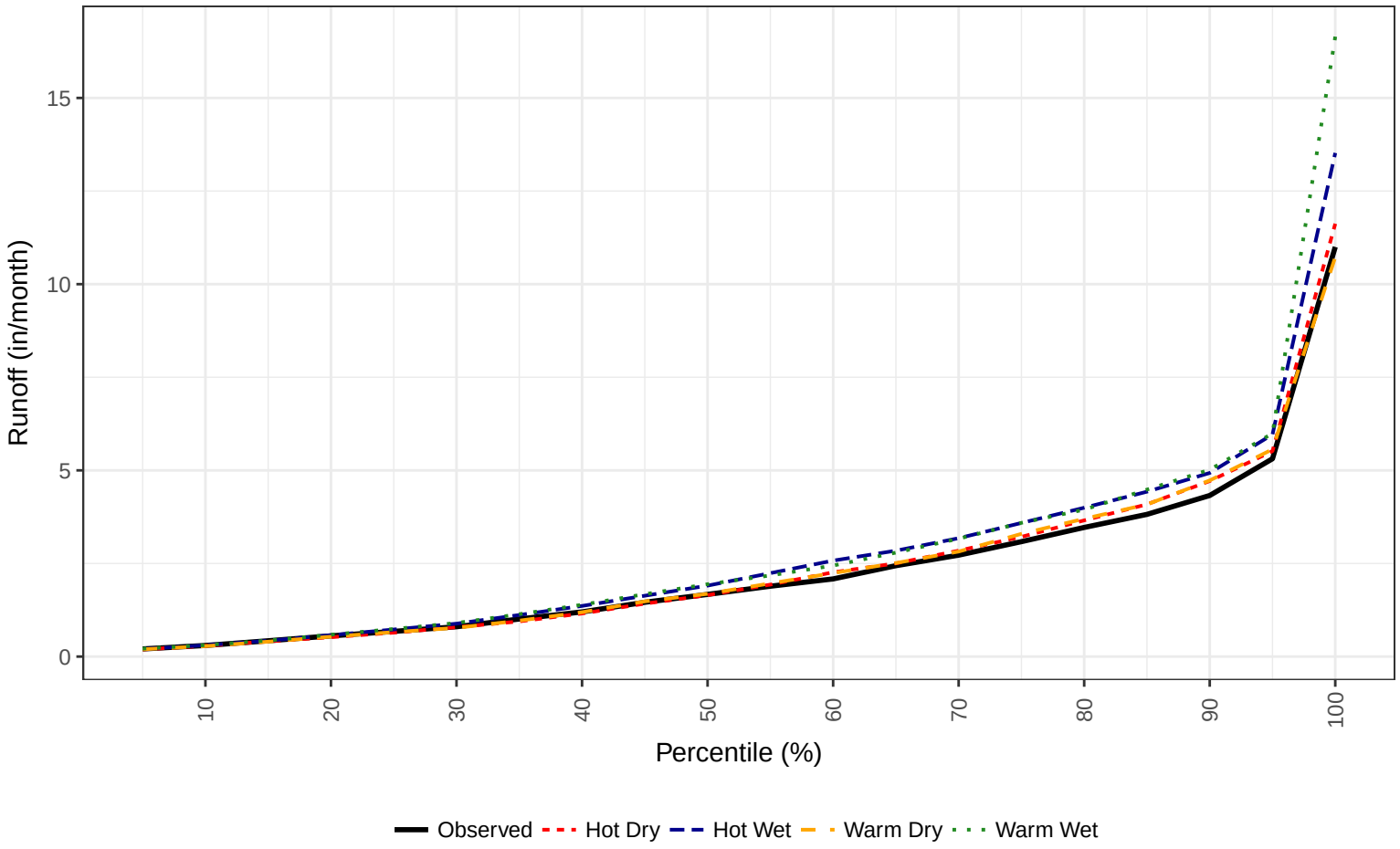


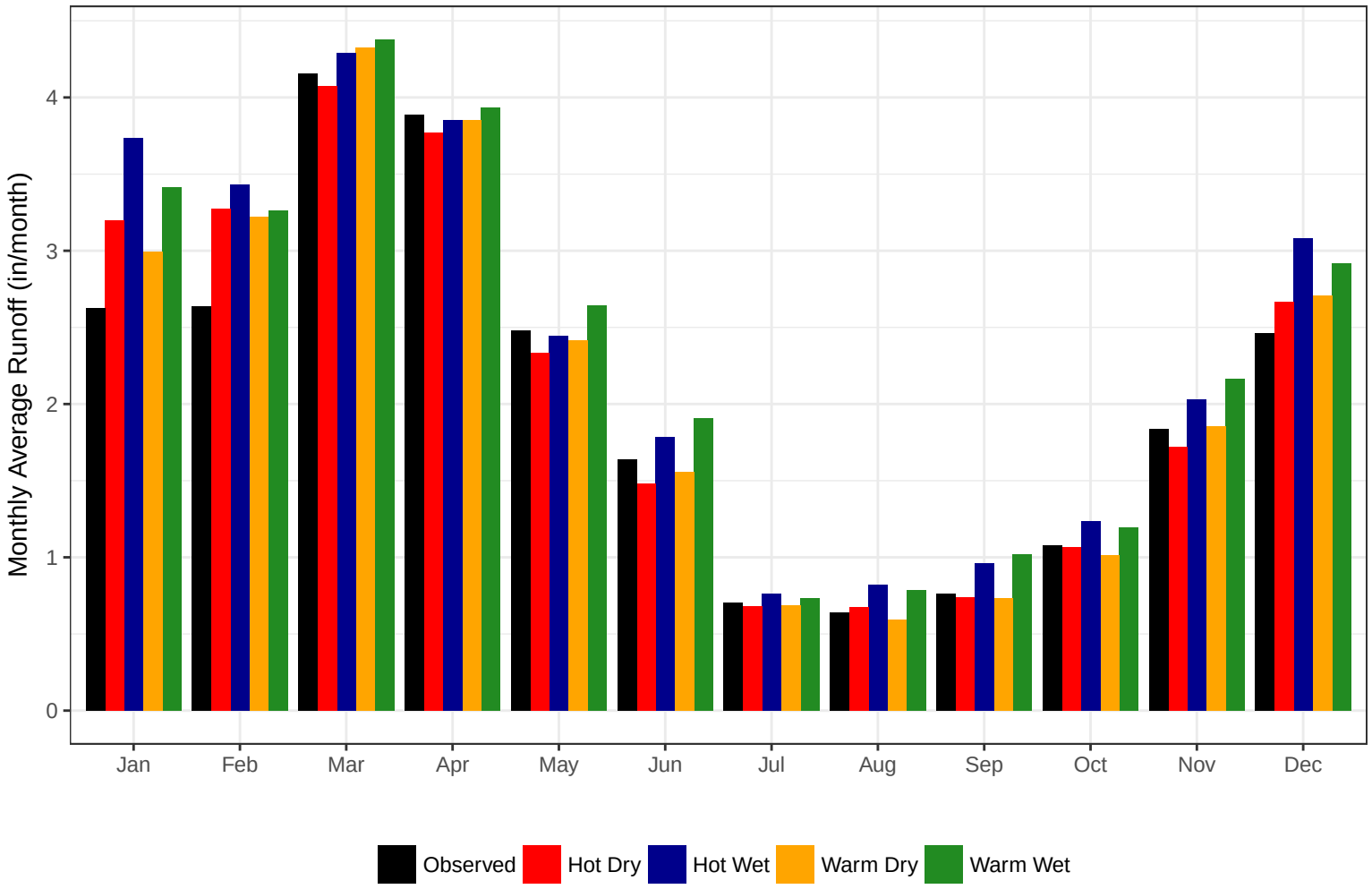
Climate Change Streamflow Projections for Shetucket Regional Basin



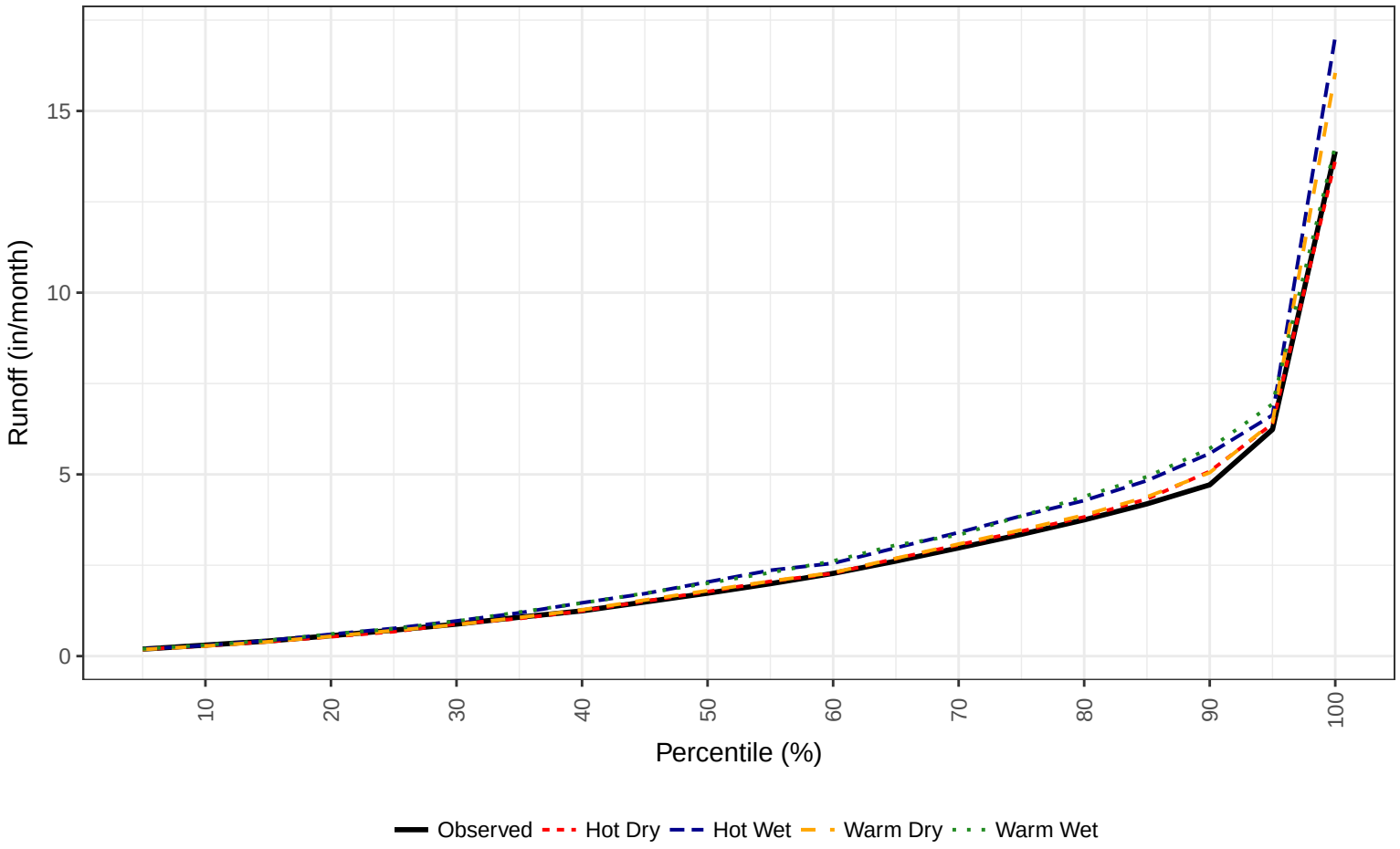


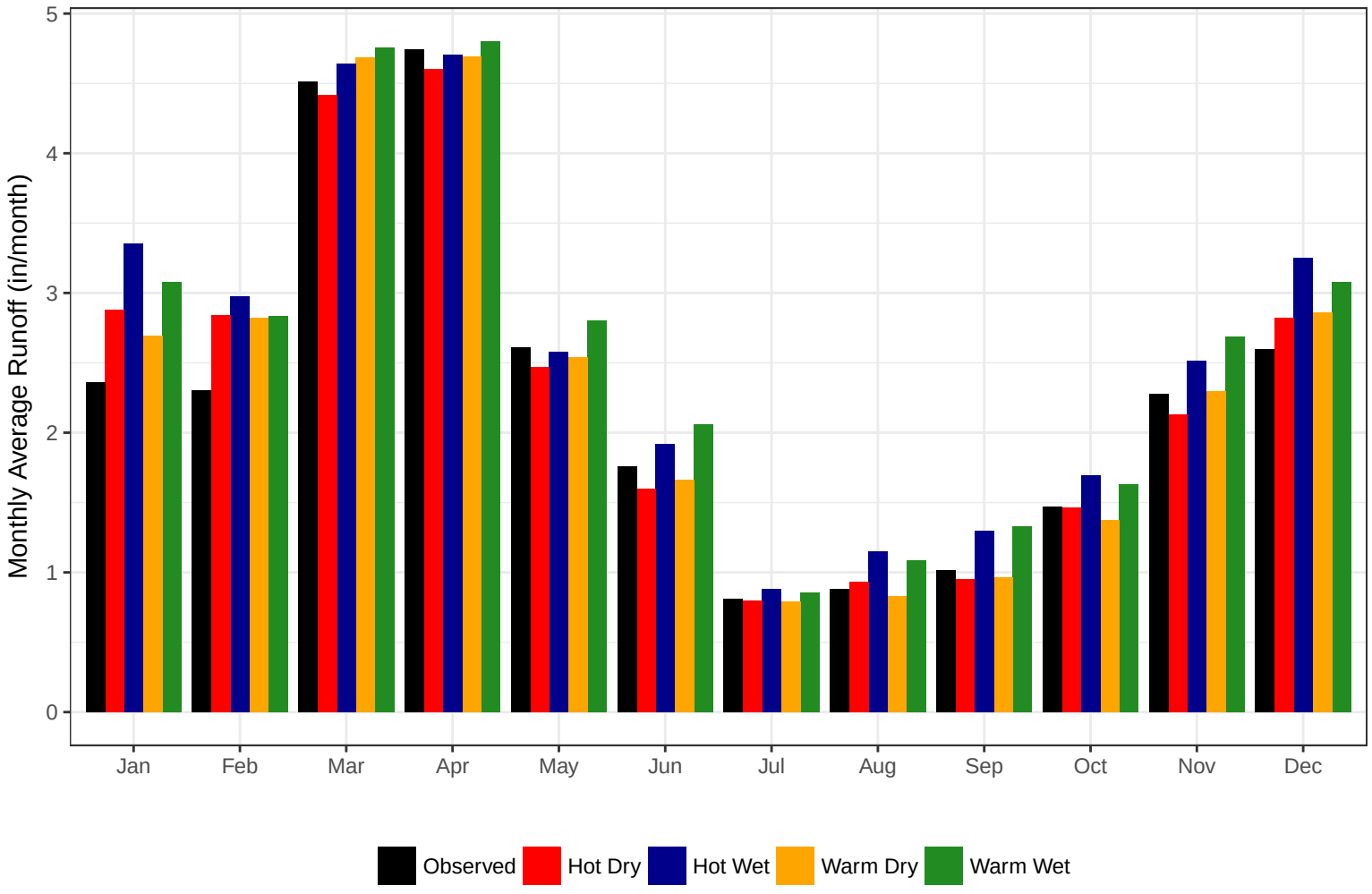
Climate Change Streamflow Projections for Yantic Regional Basin



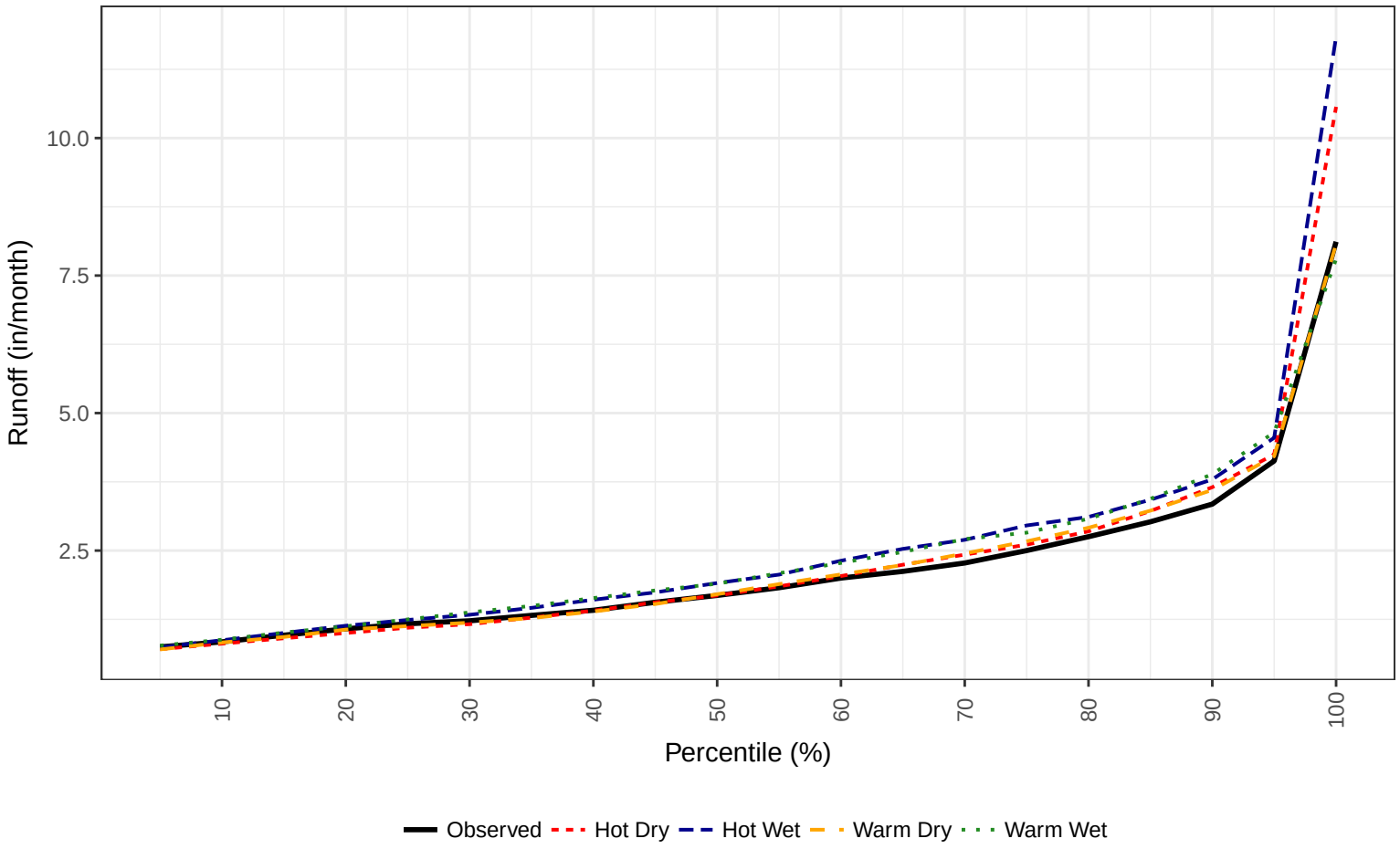


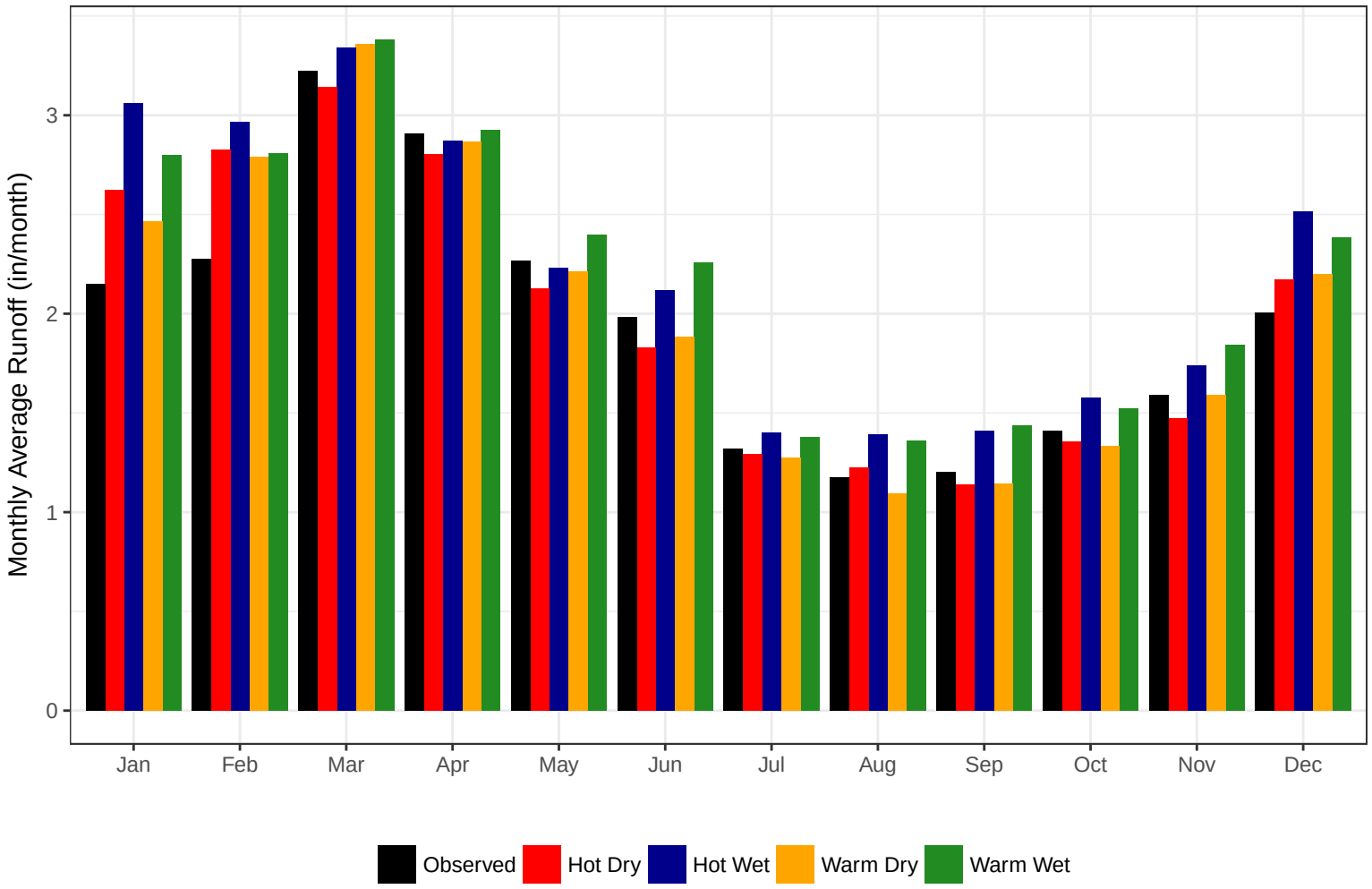
Climate Change Streamflow Projections for Connecticut Main Stem Regional Basin



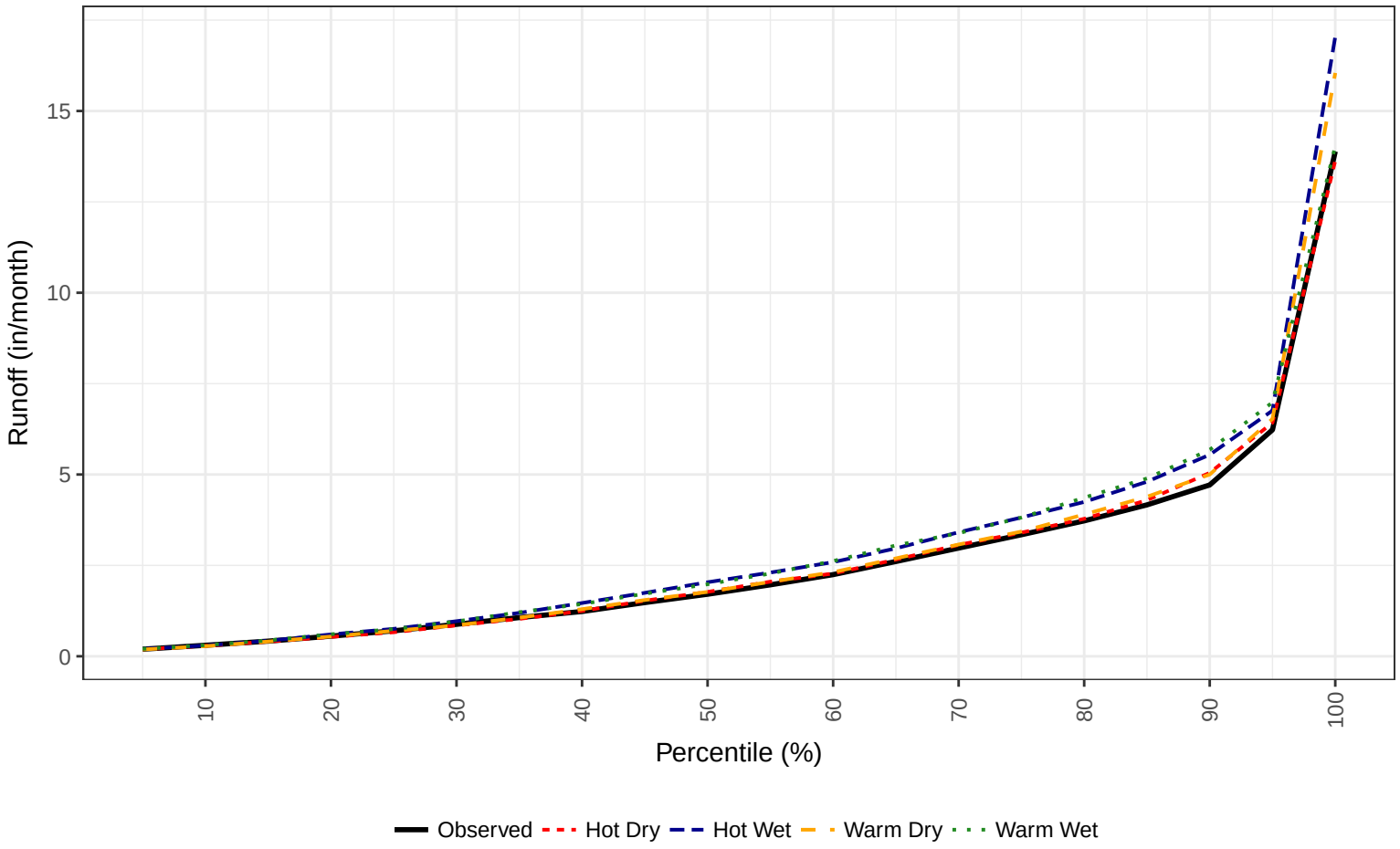


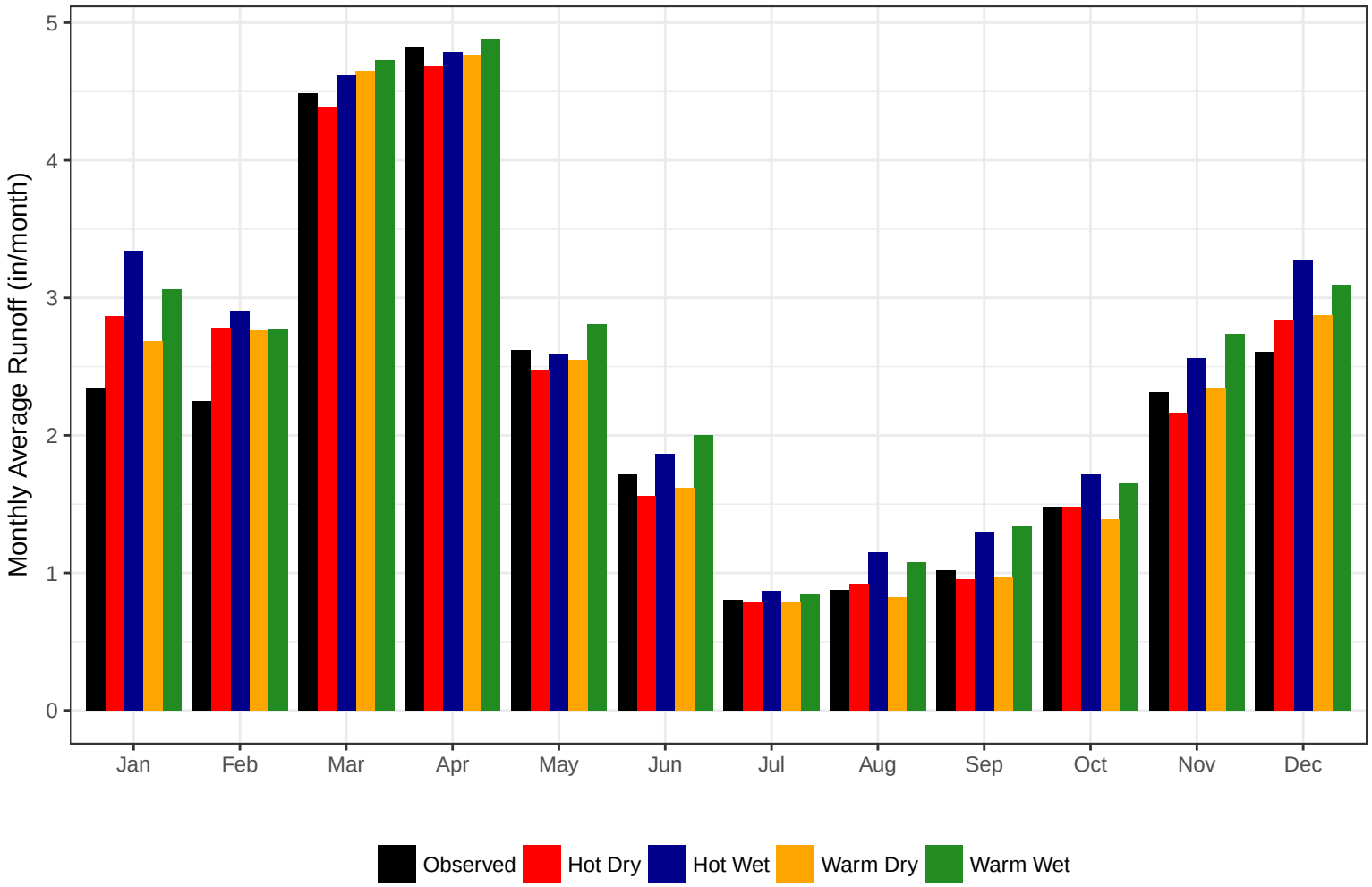
Climate Change Streamflow Projections for Stony Brook Regional Basin



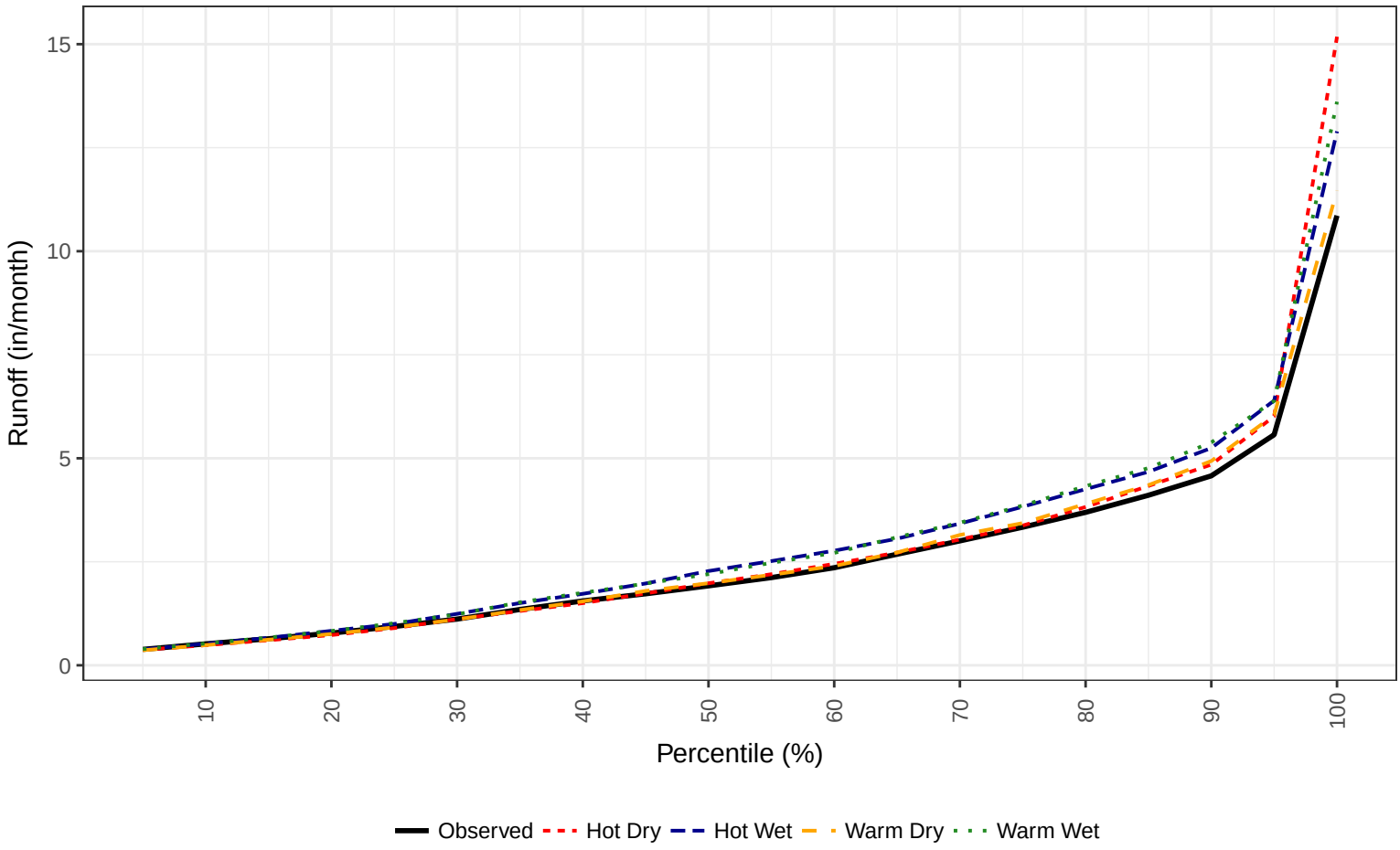


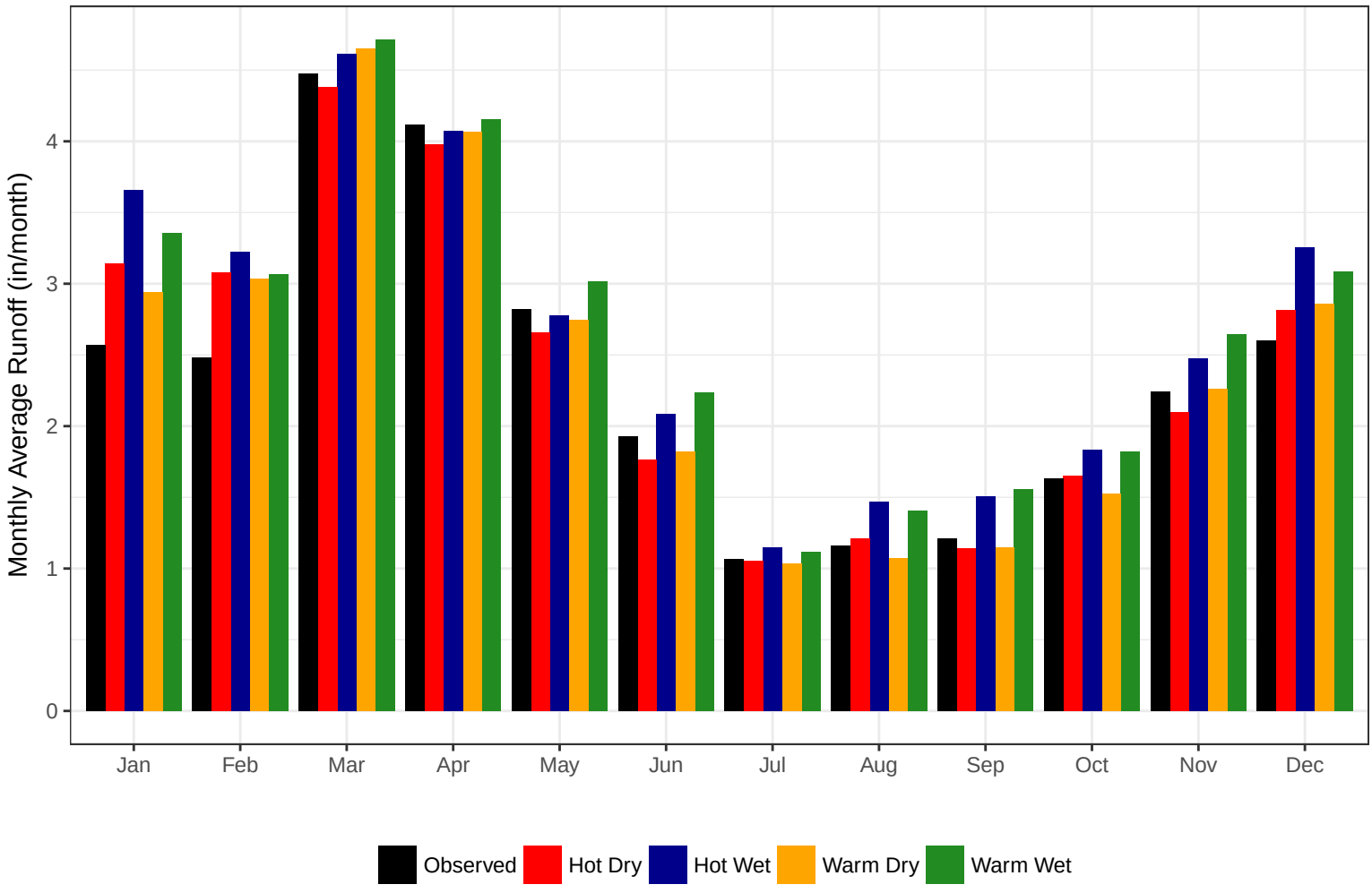
Climate Change Streamflow Projections for Scantic Regional Basin



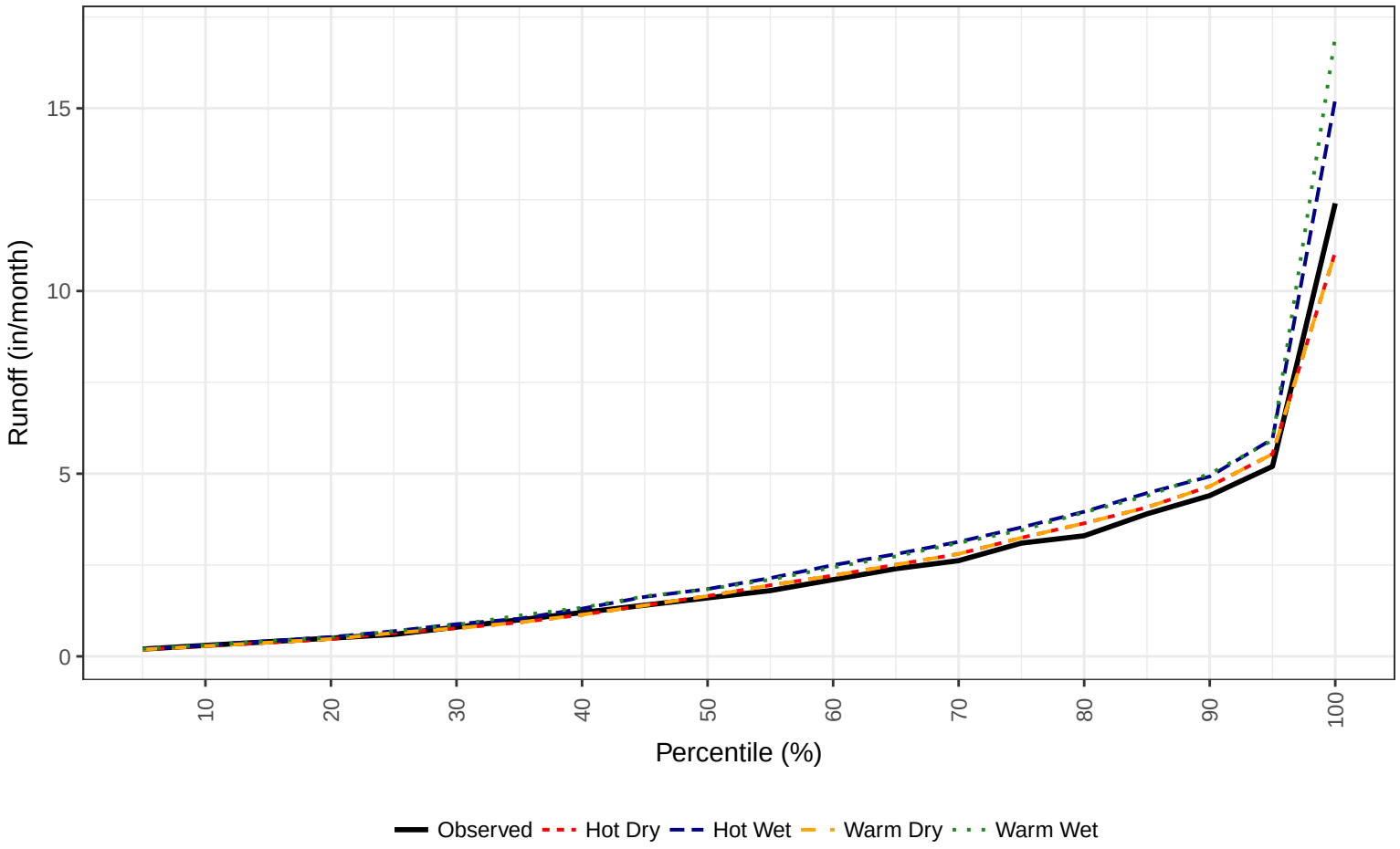


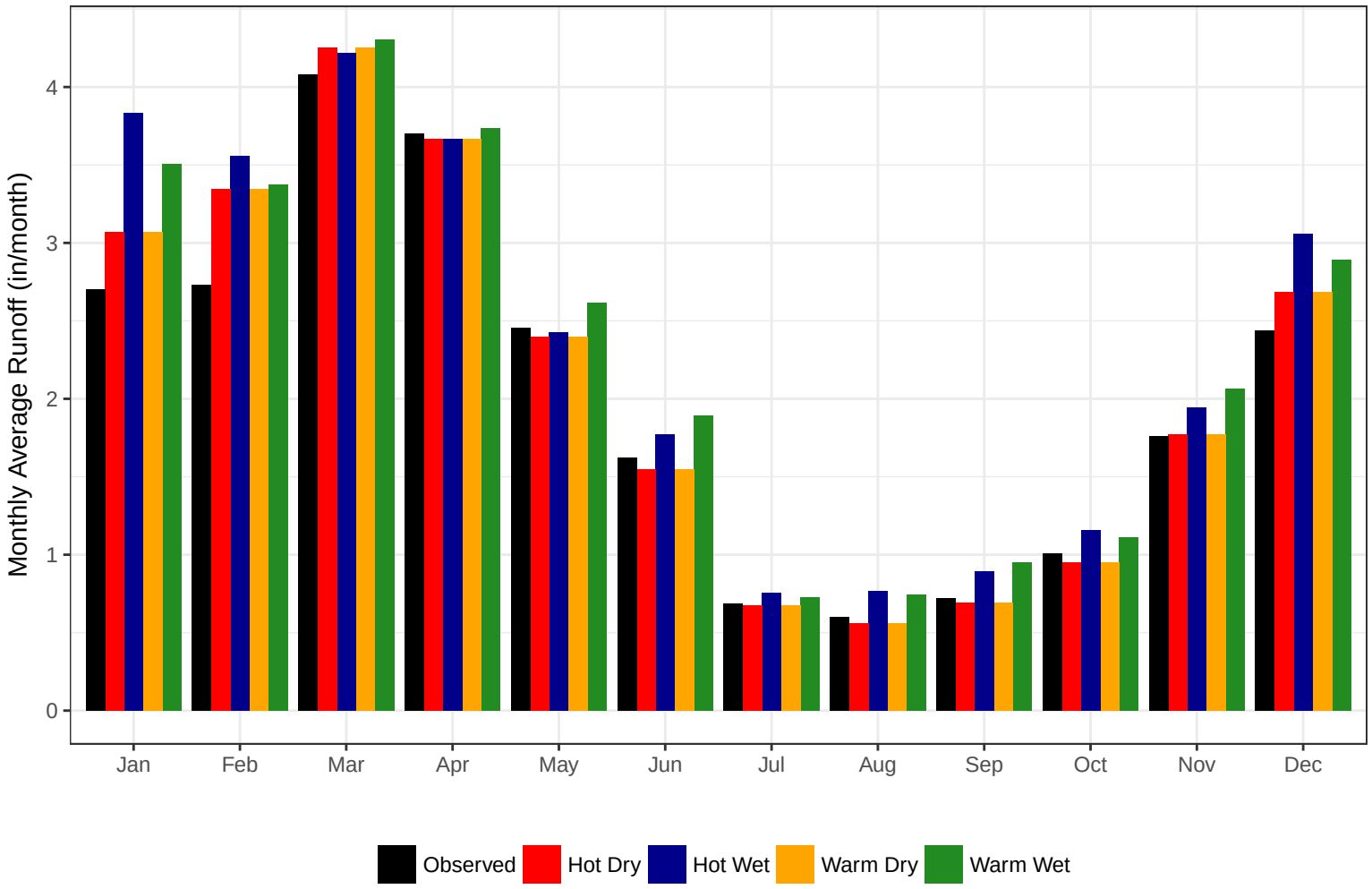
Climate Change Streamflow Projections for Farmington Regional Basin



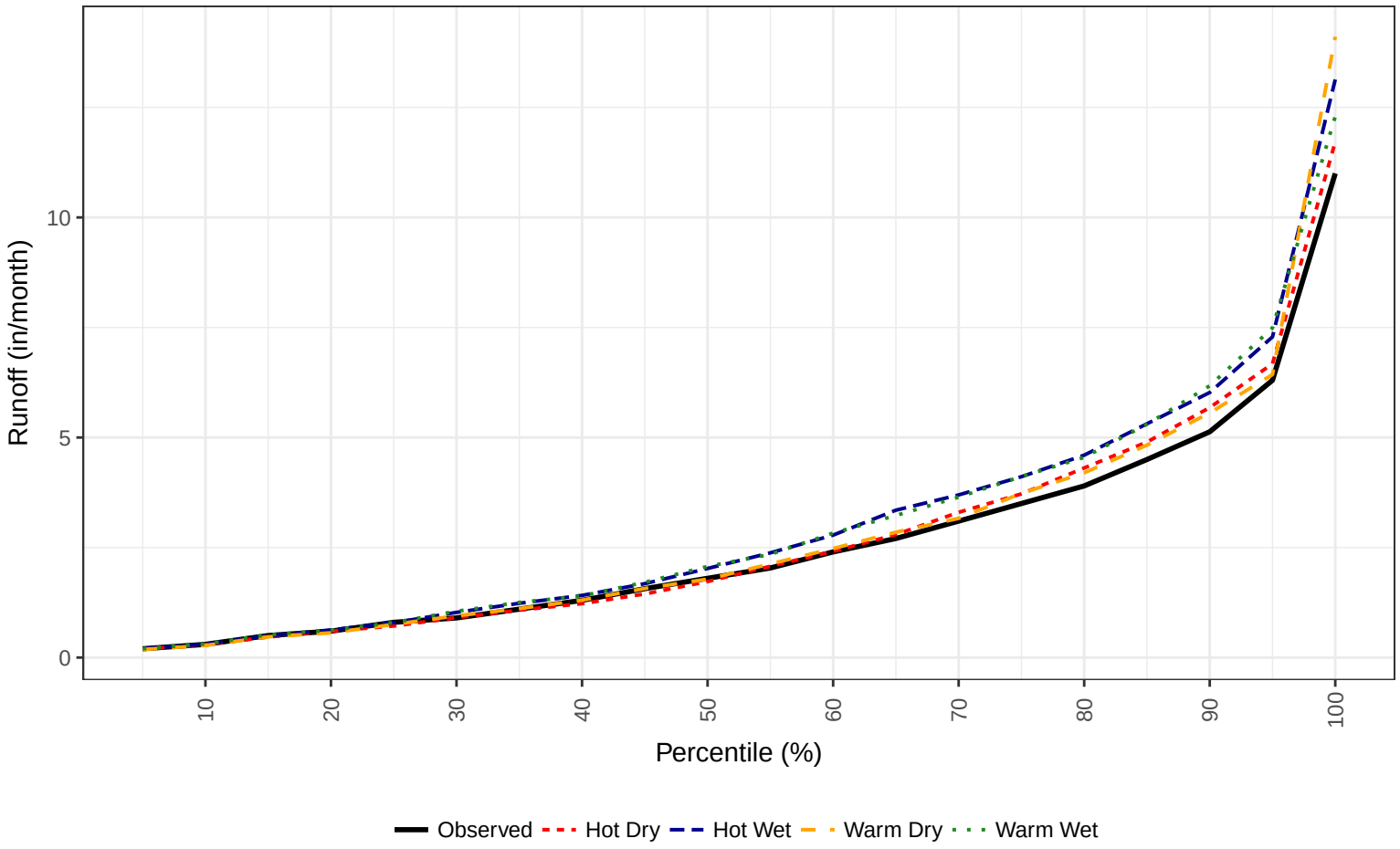


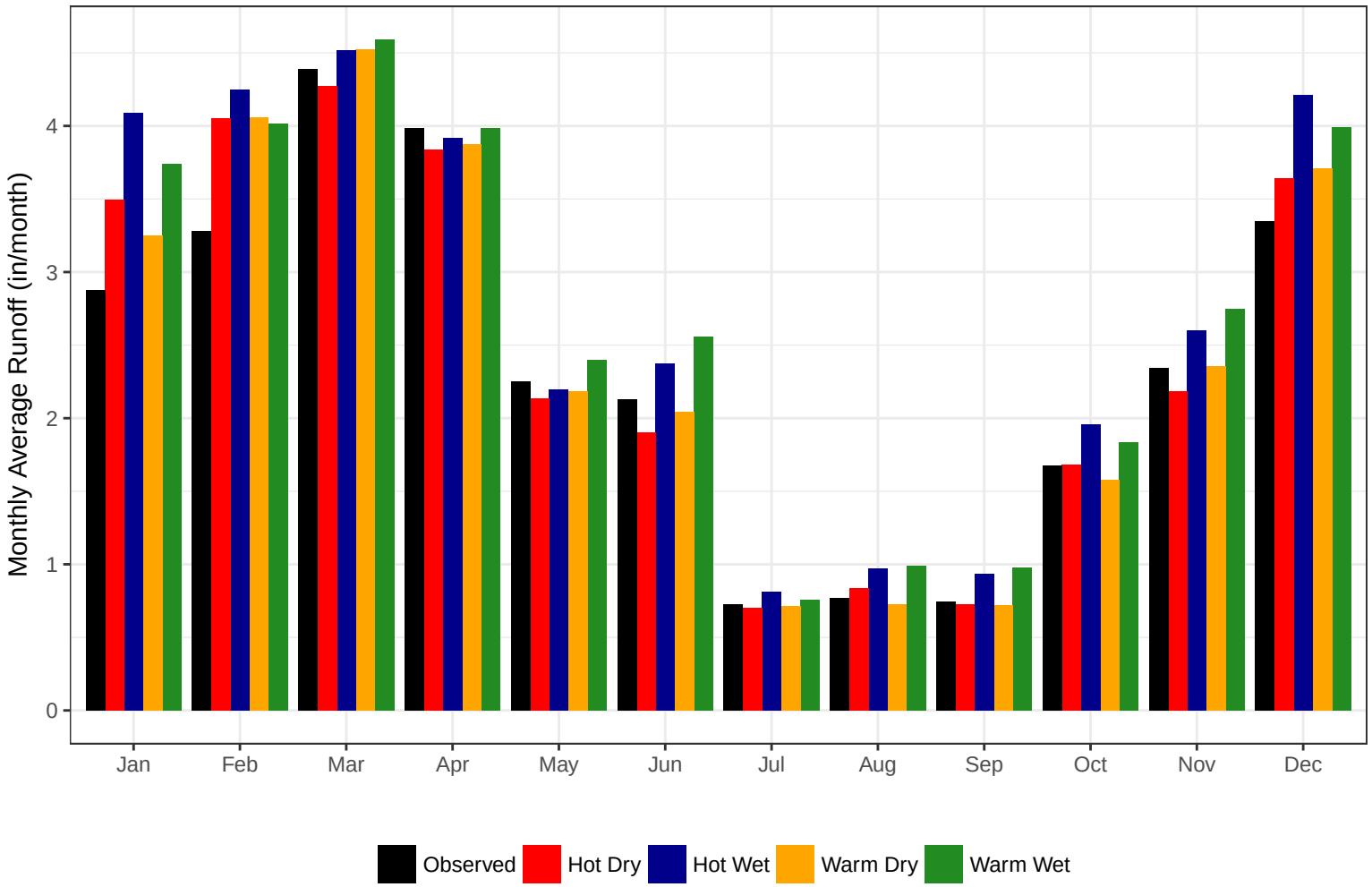
Climate Change Streamflow Projections for Park Regional Basin



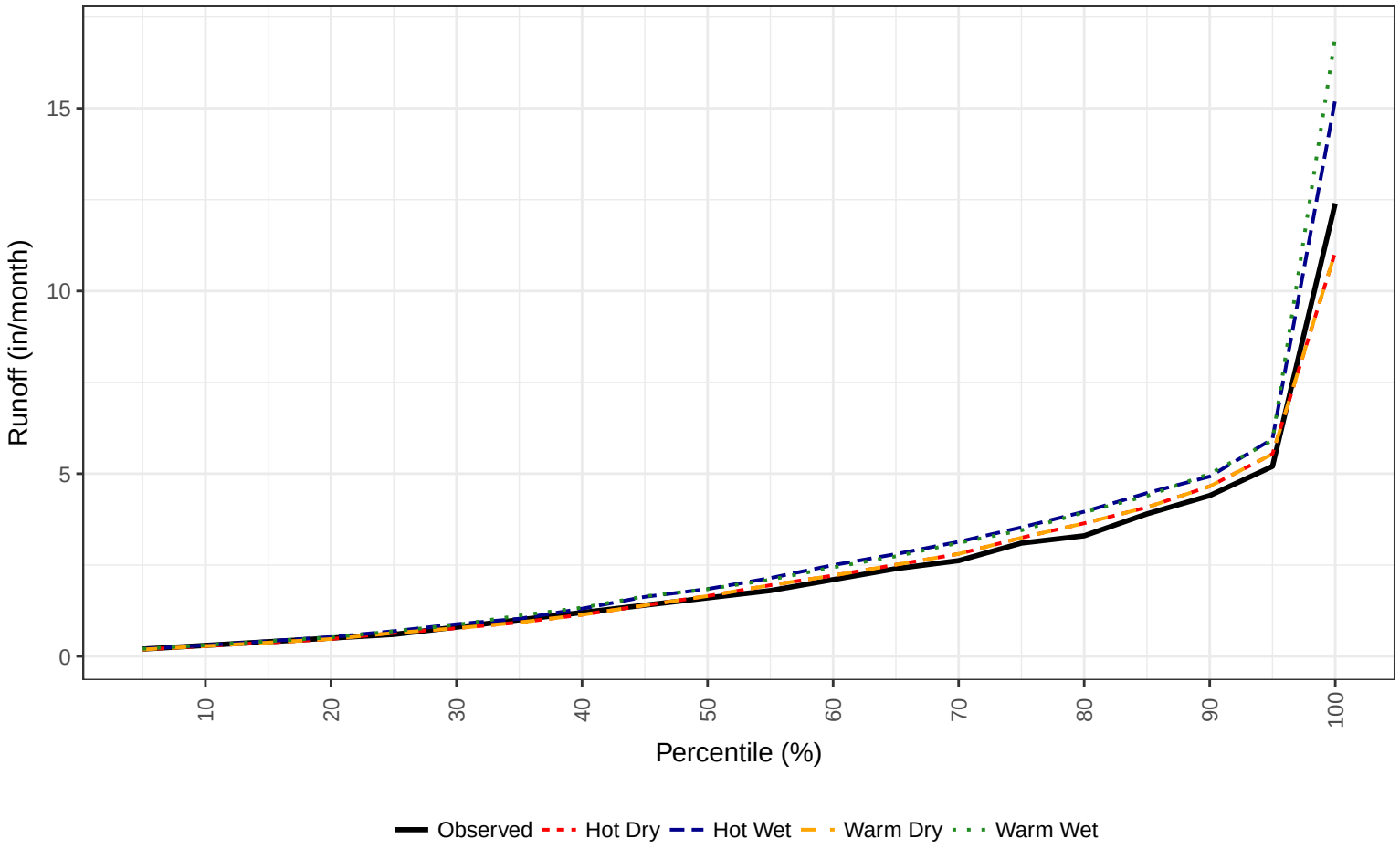


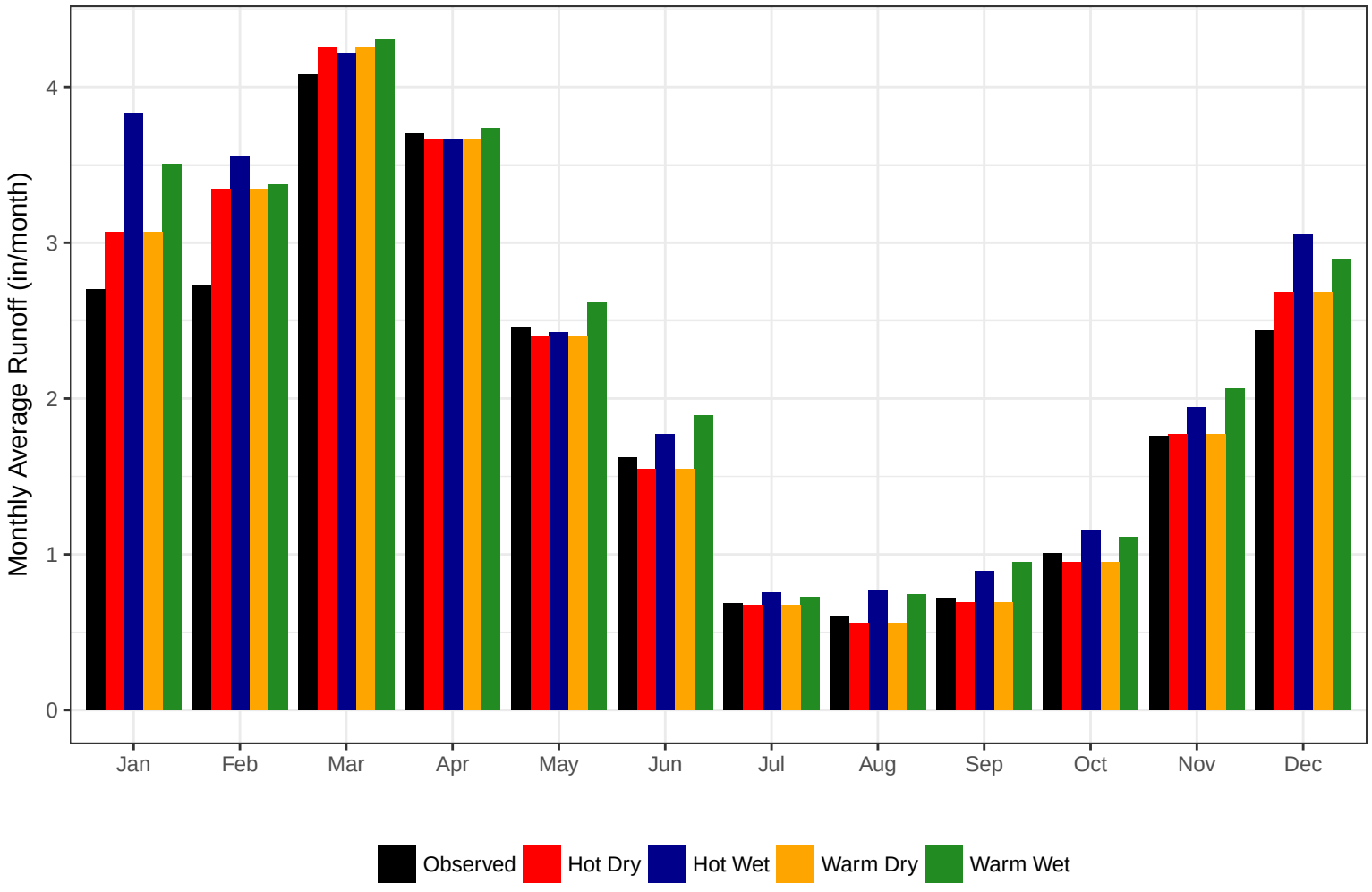
Climate Change Streamflow Projections for Hockanum Regional Basin



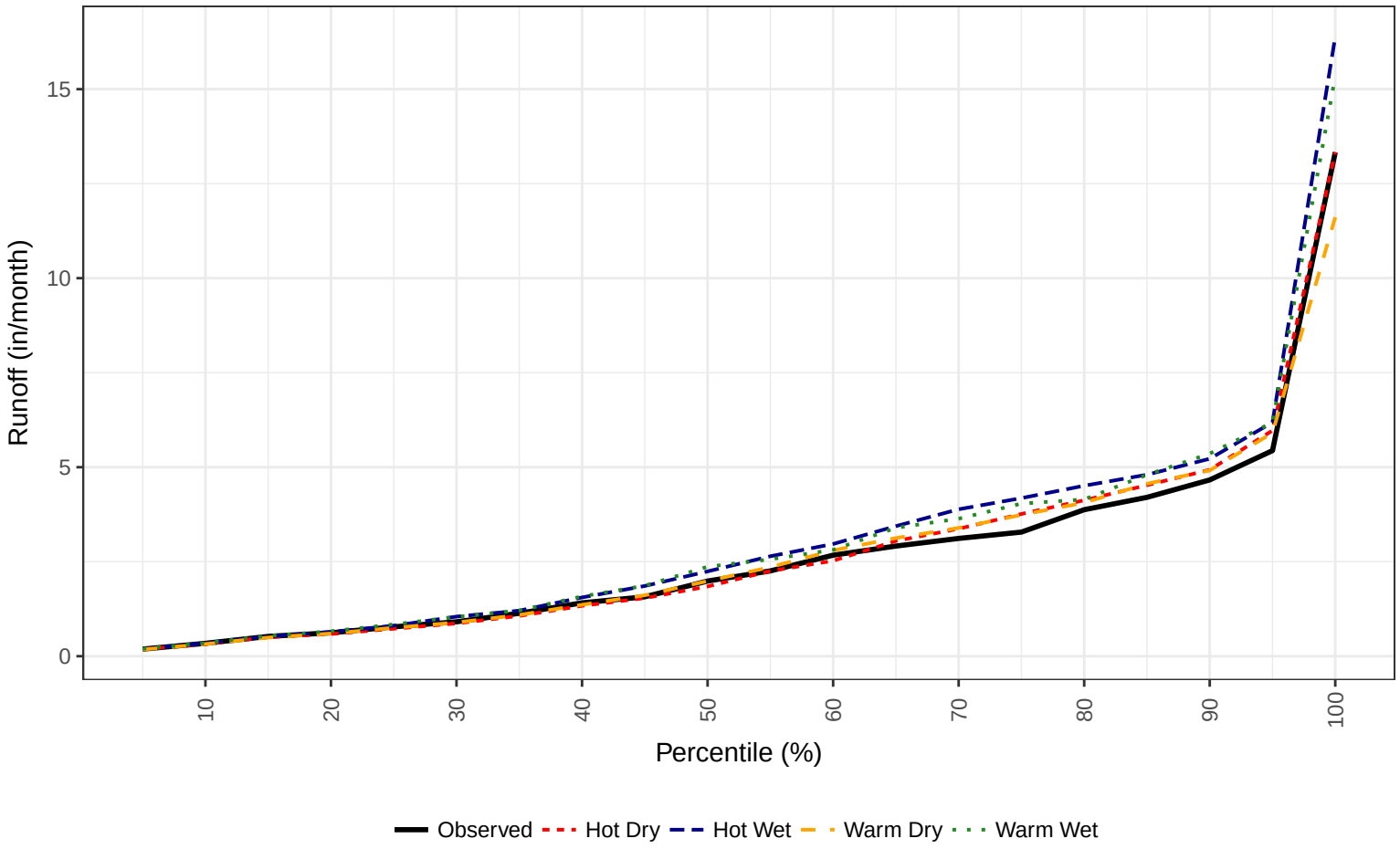


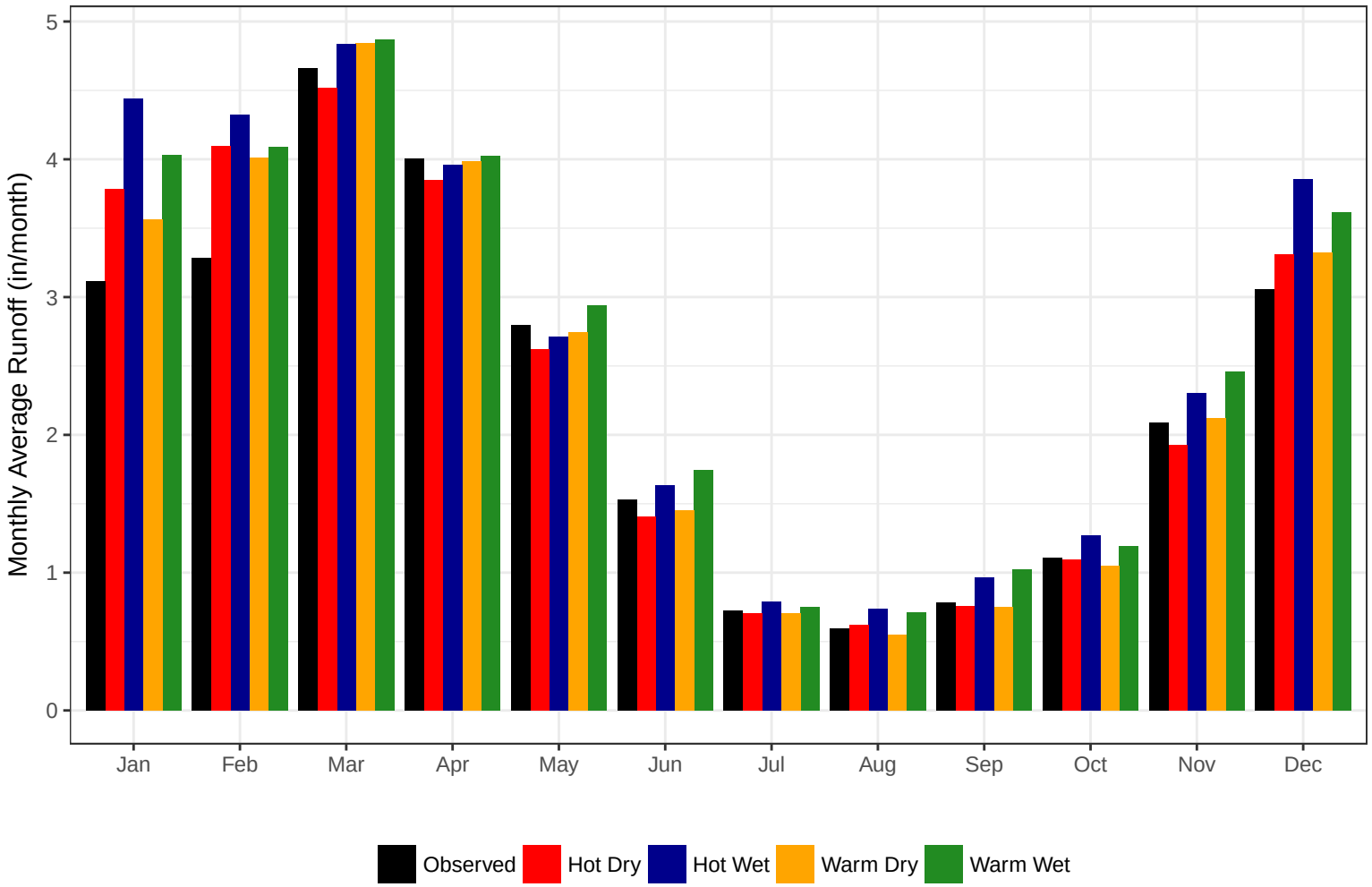
Climate Change Streamflow Projections for Mattabesset Regional Basin



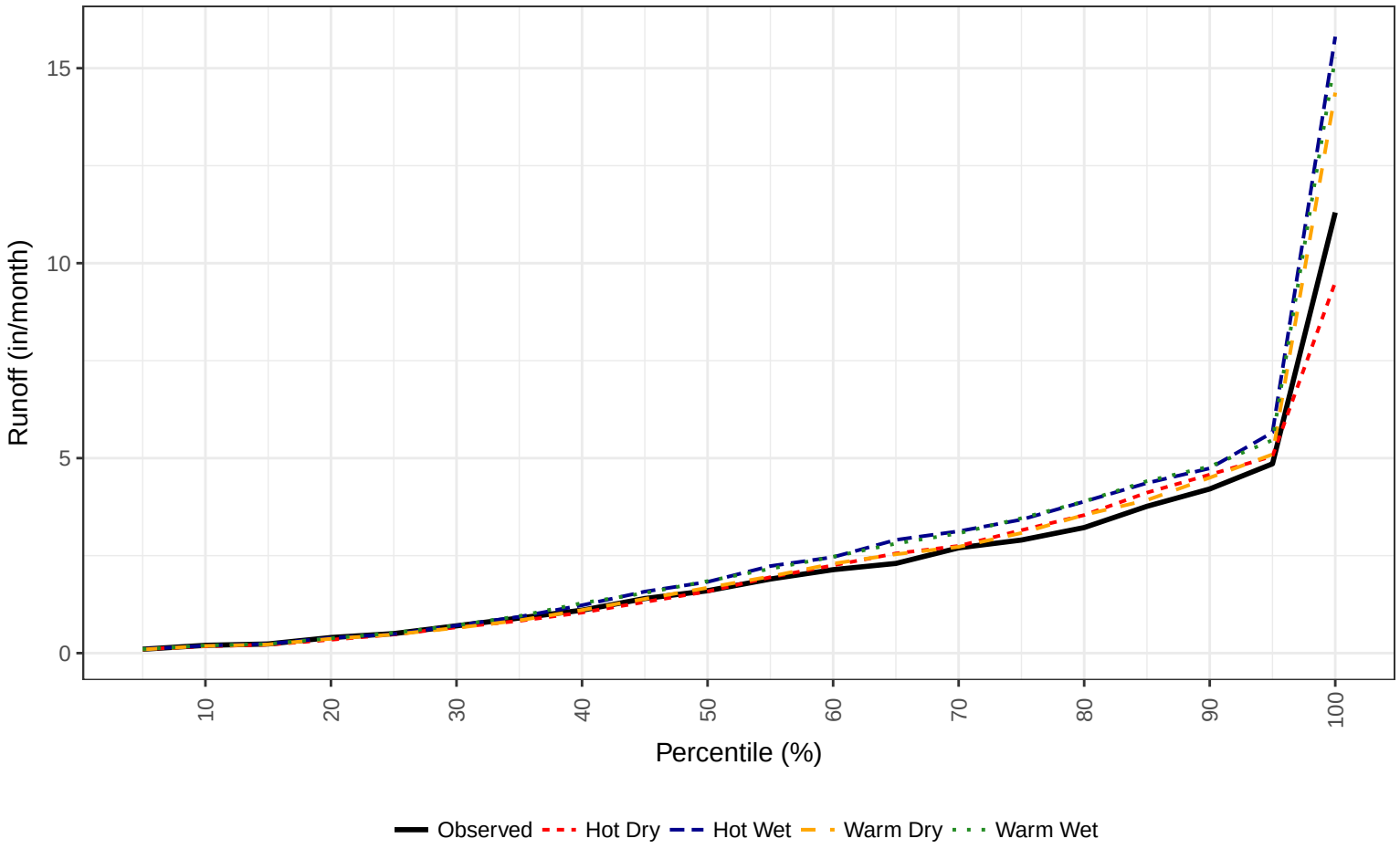


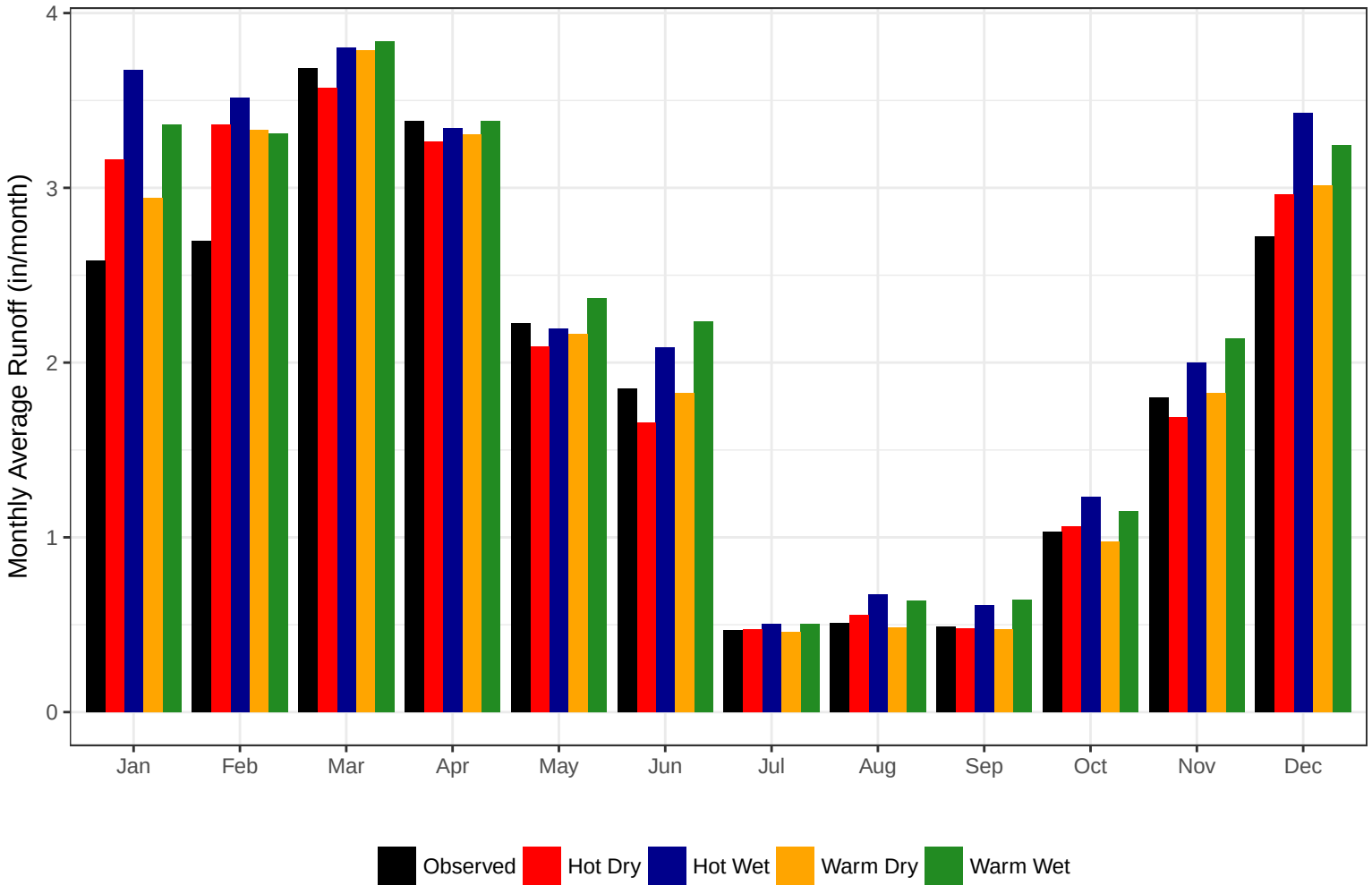
Climate Change Streamflow Projections for Salmon Regional Basin



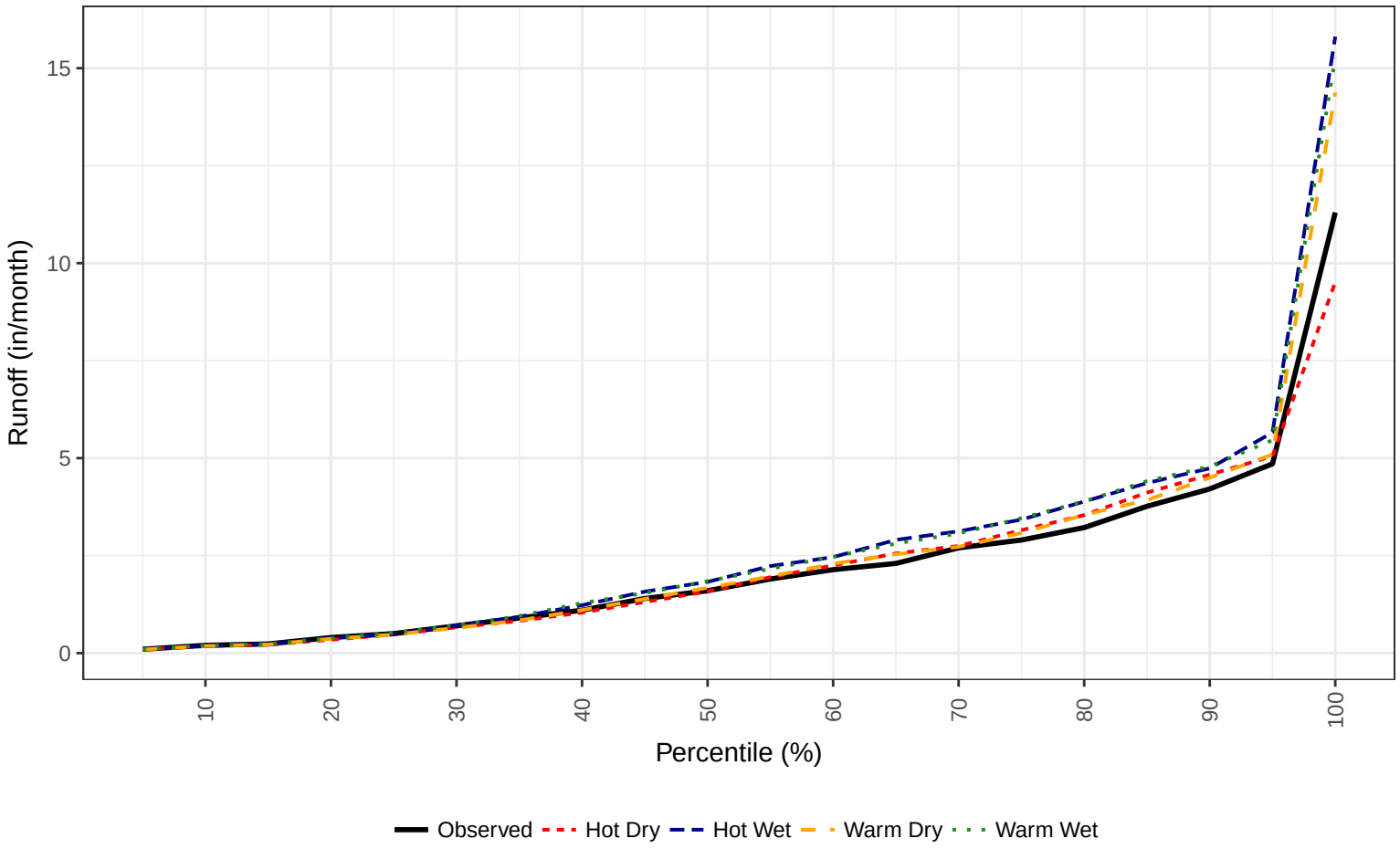


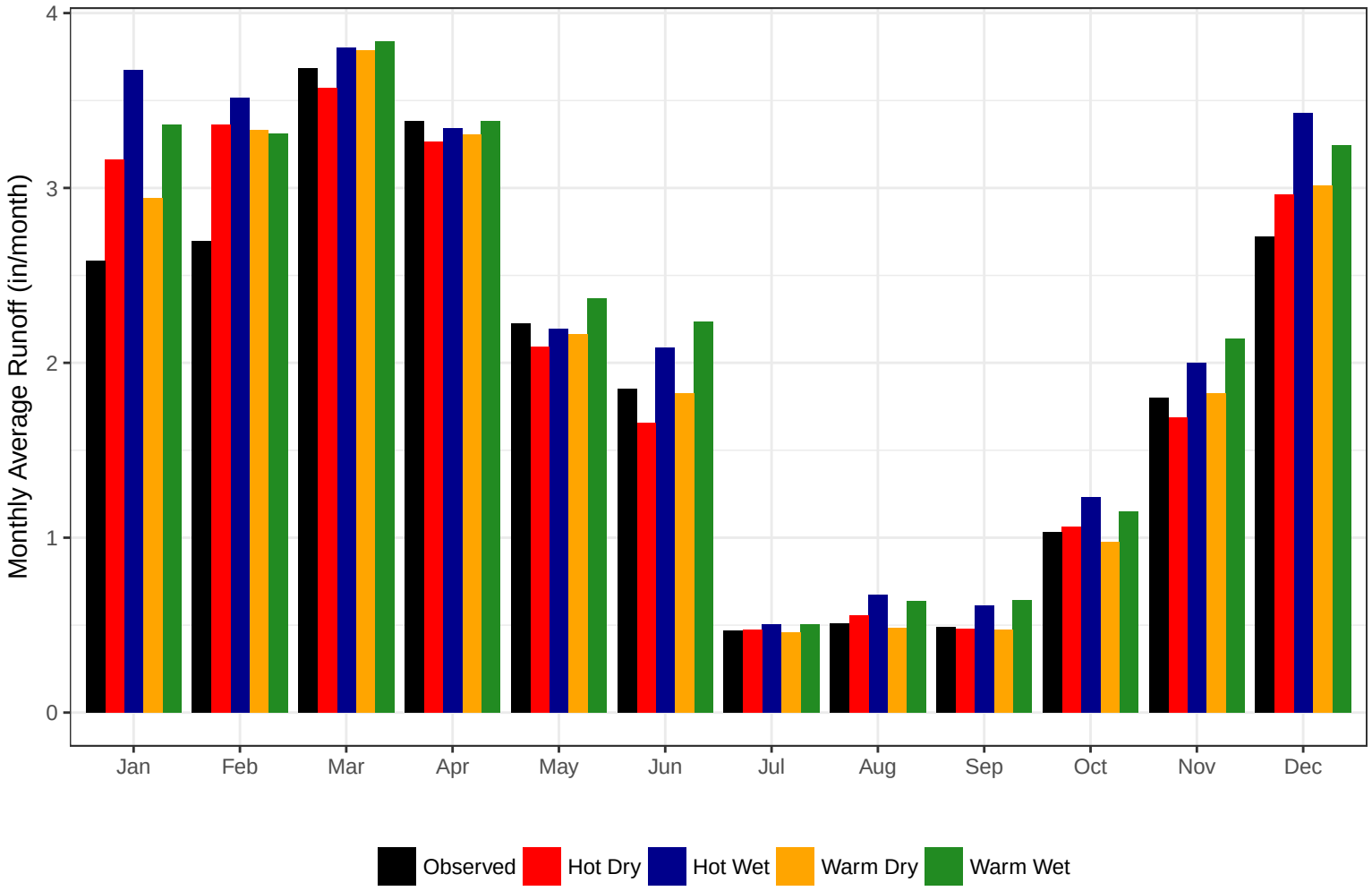
Climate Change Streamflow Projections for Eightmile Regional Basin



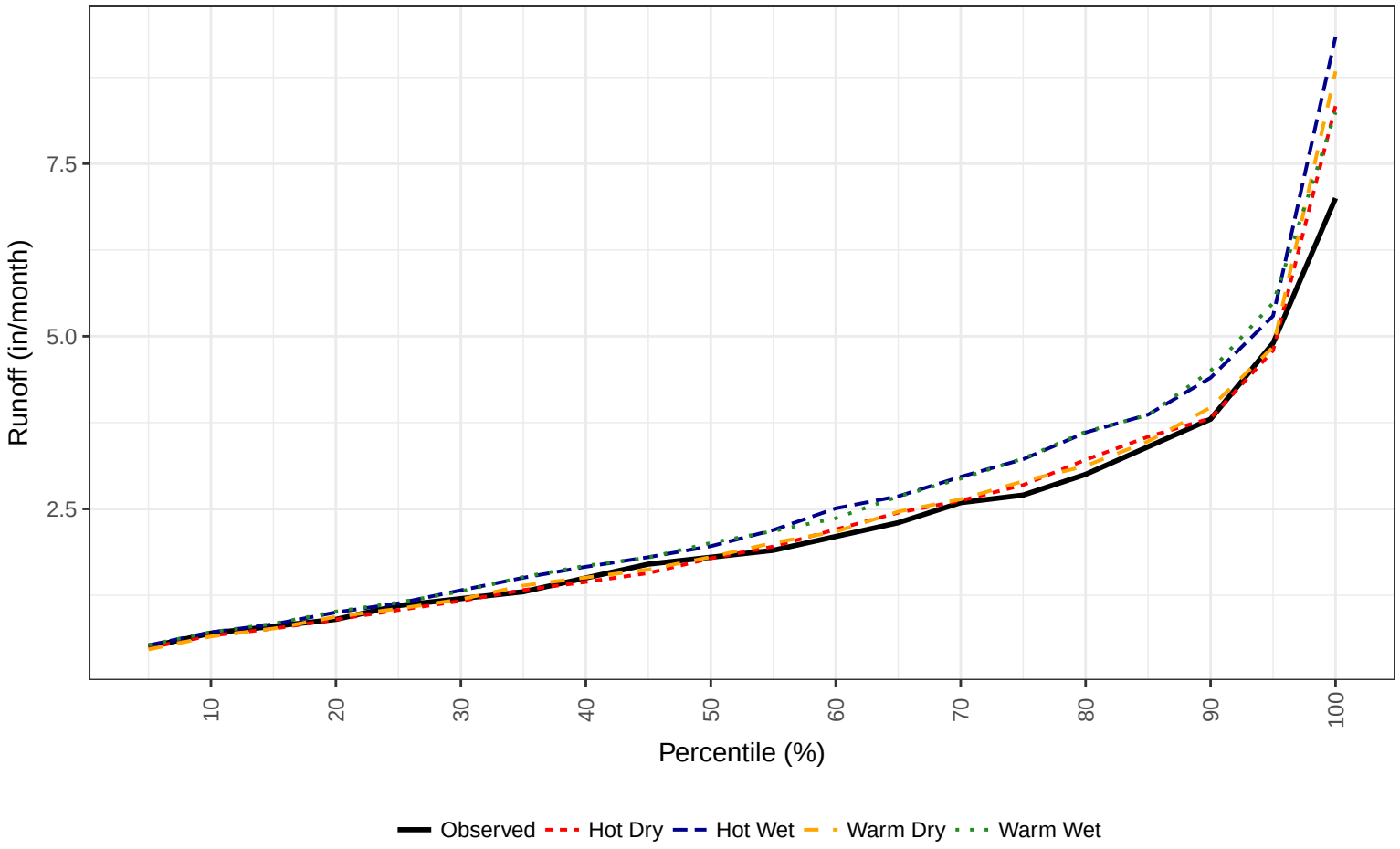


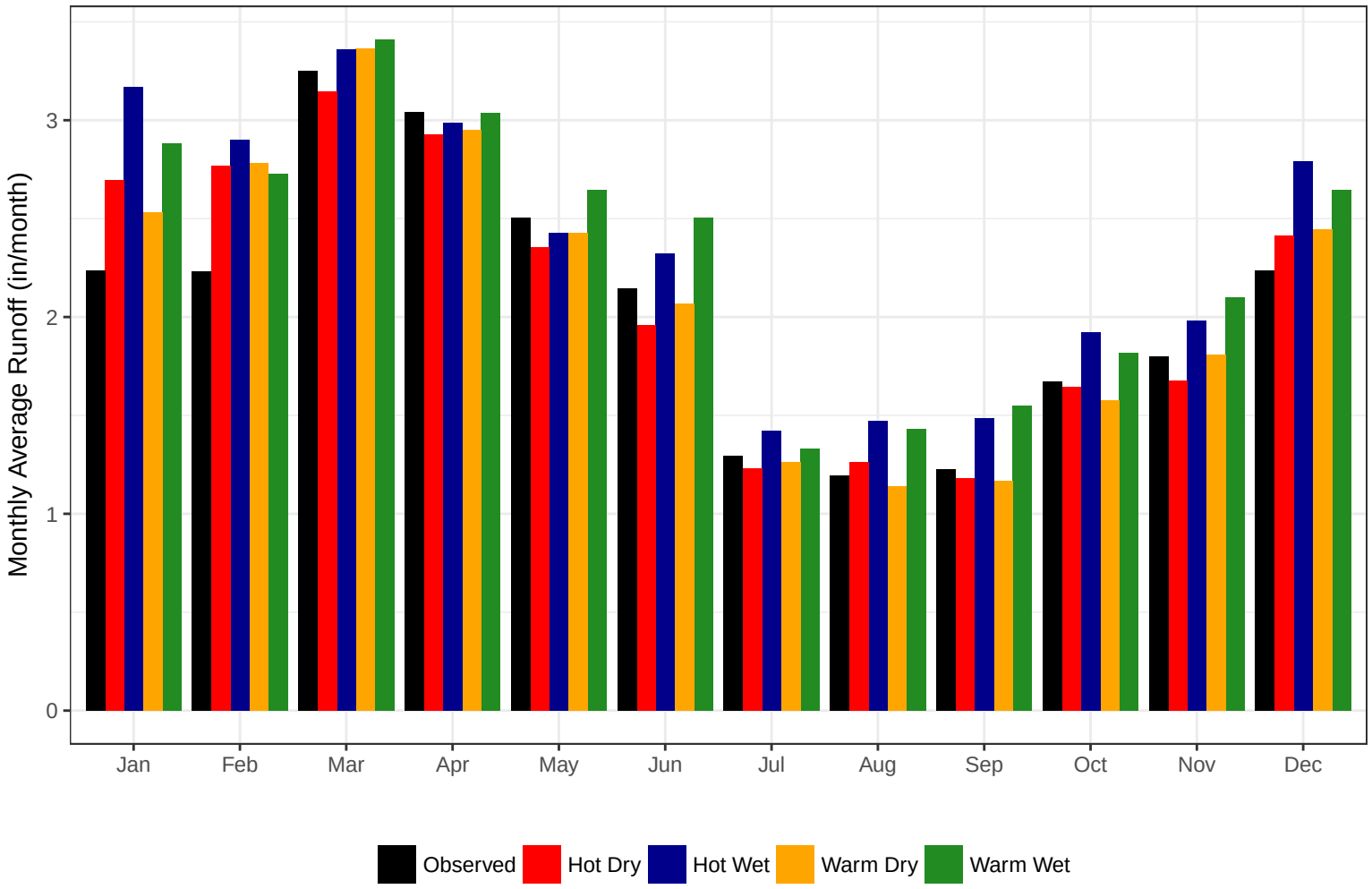
Climate Change Streamflow Projections for South Central Shoreline Regional Basin



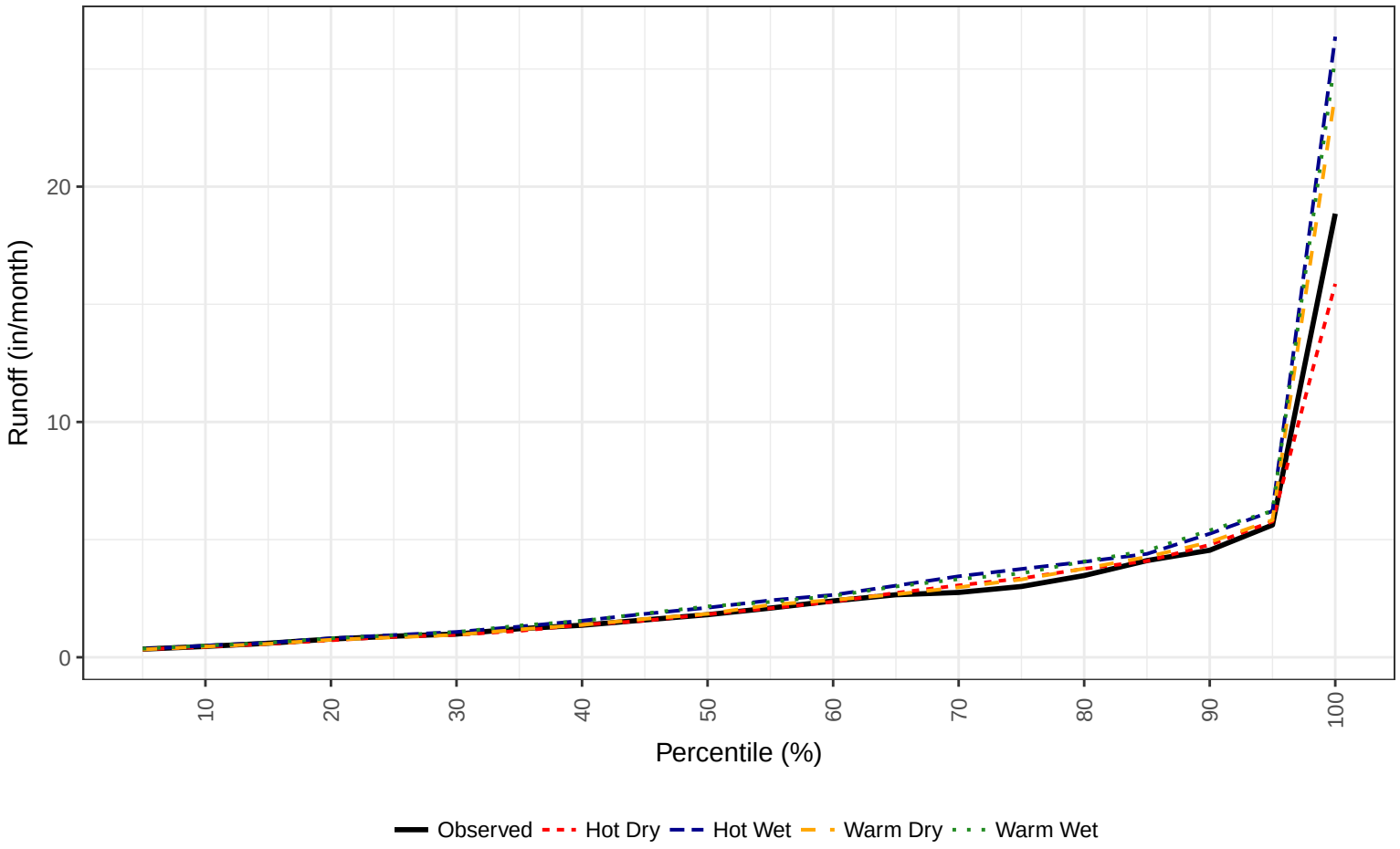


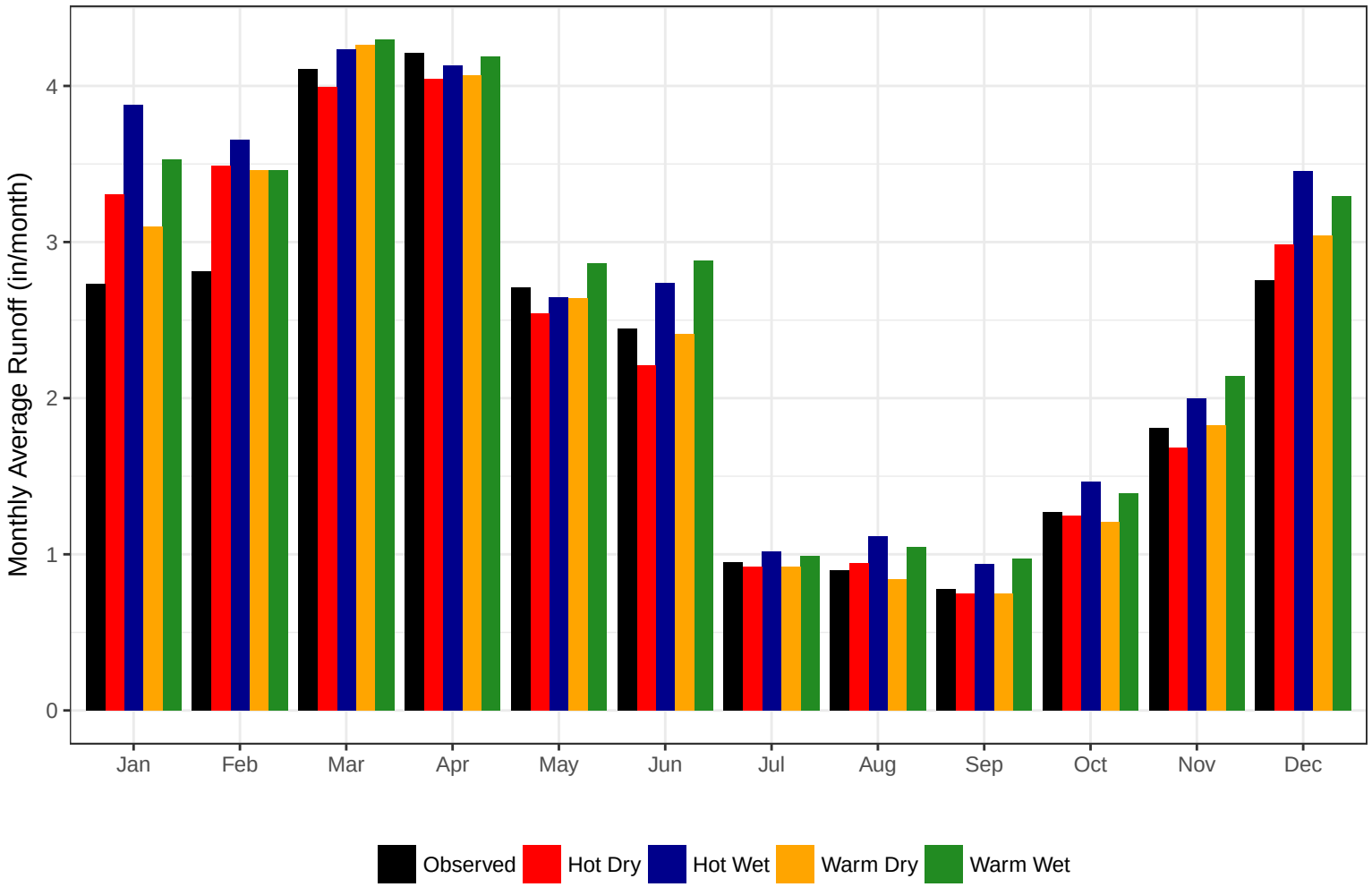
Climate Change Streamflow Projections for South Central Eastern Complex Regional Basin



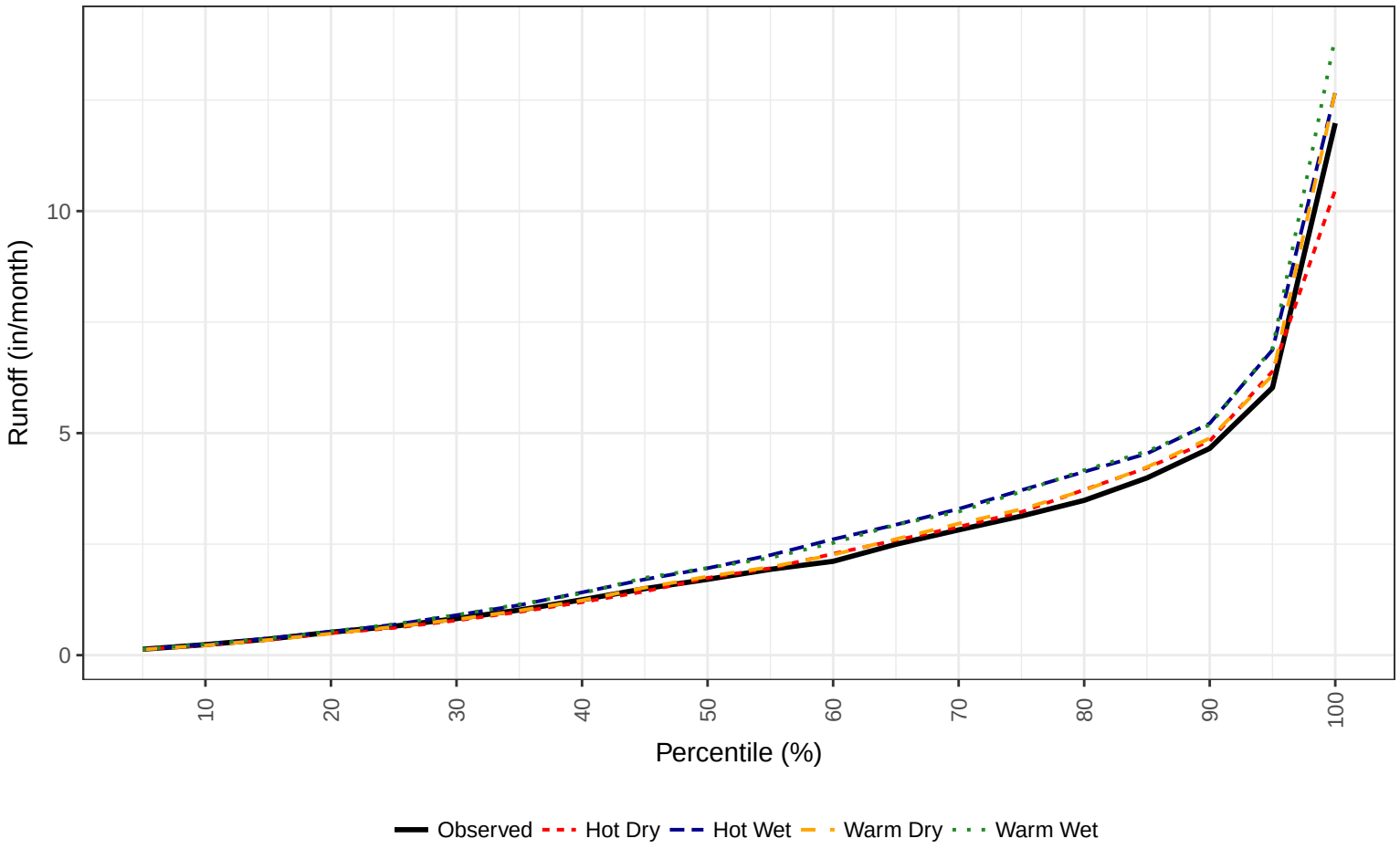


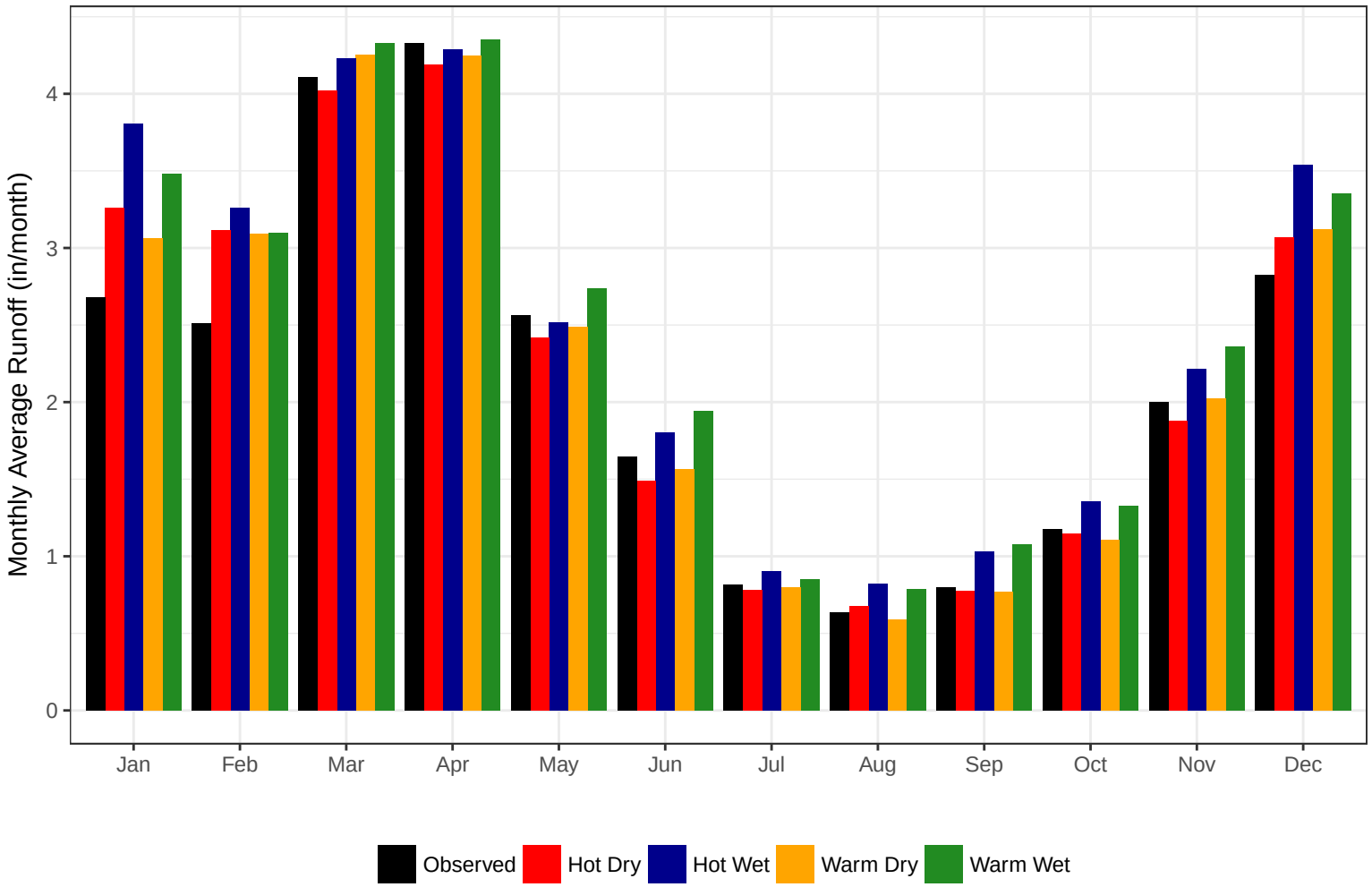
Climate Change Streamflow Projections for Quinnipiac Regional Basin



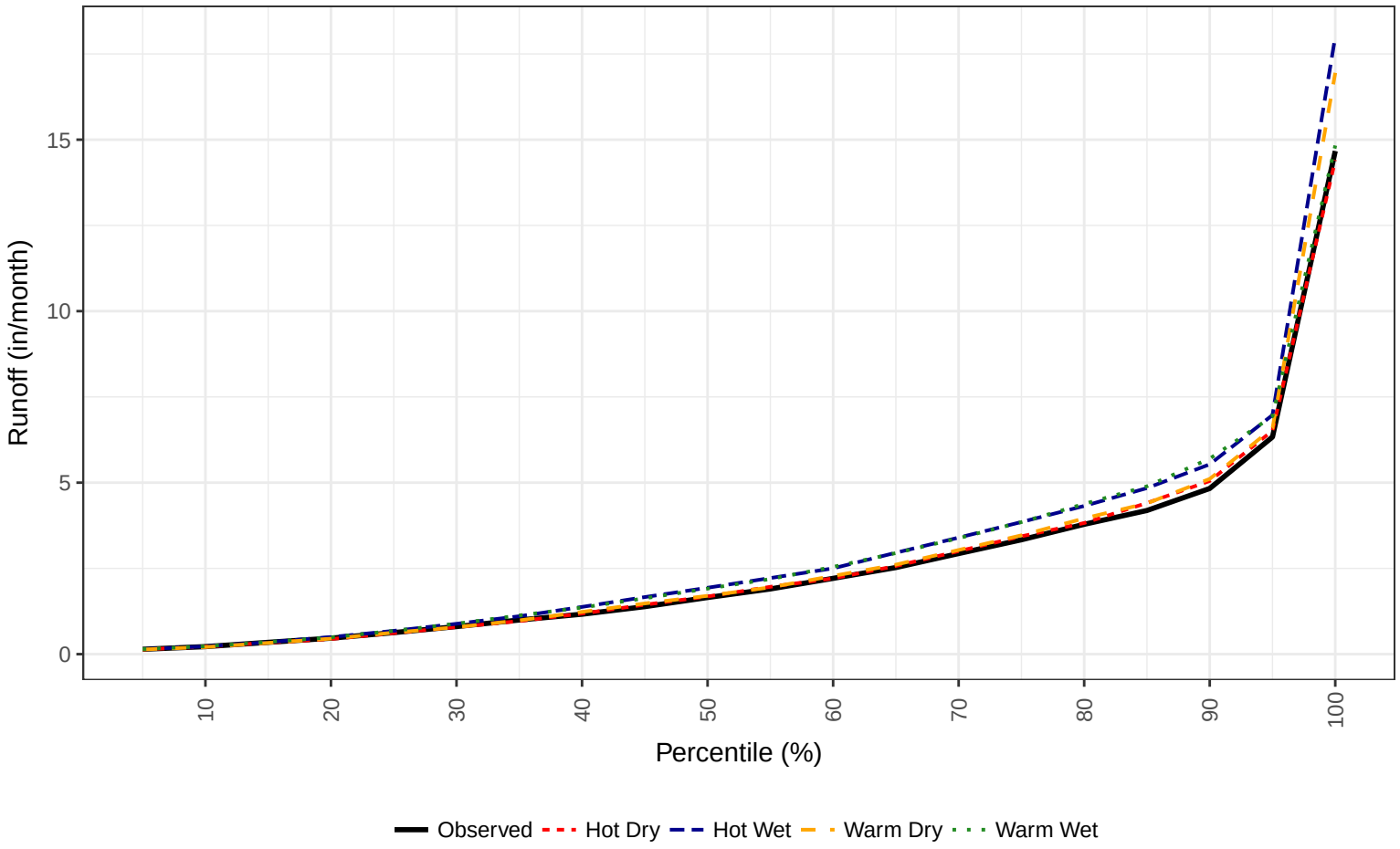


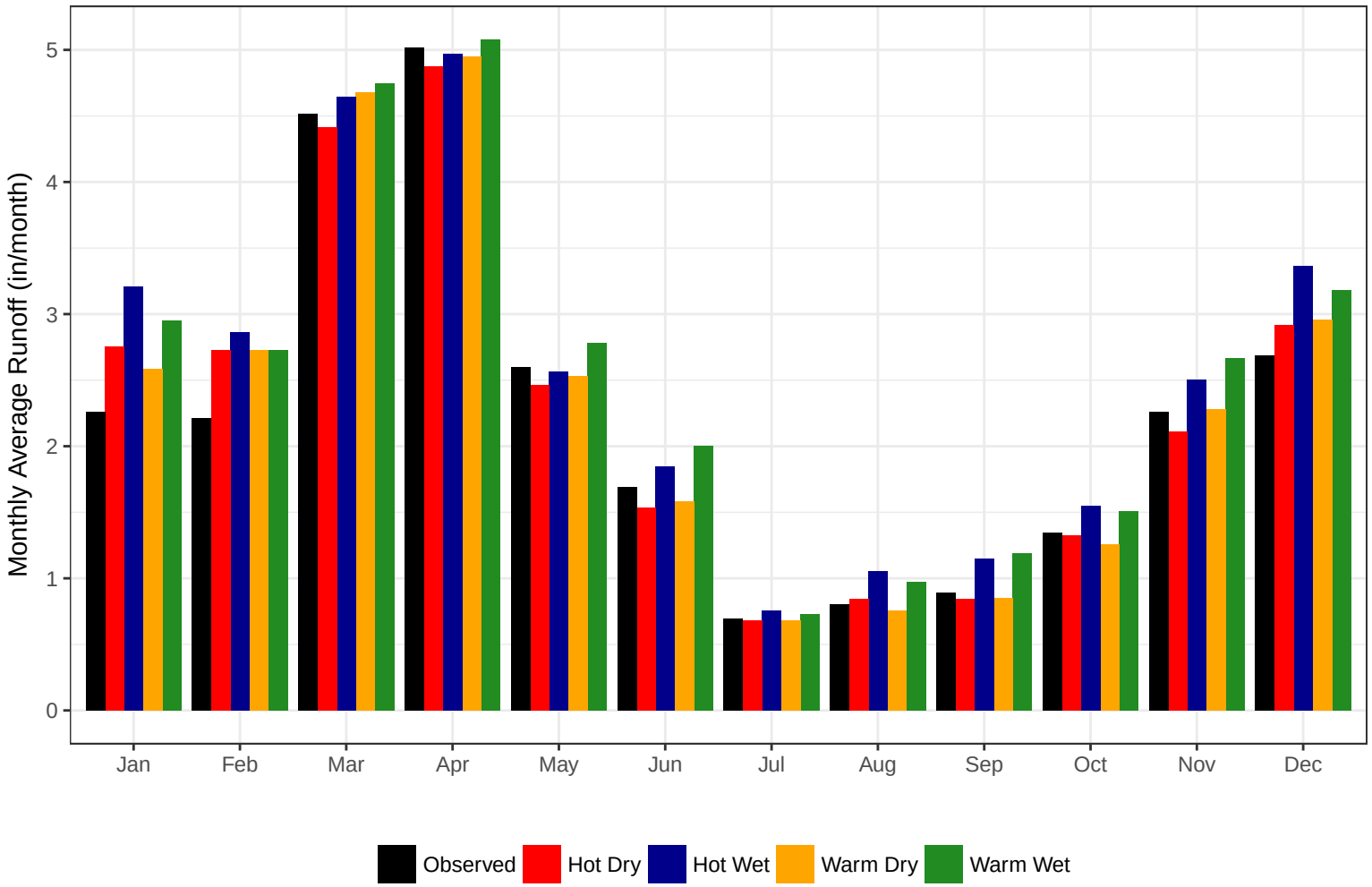
Climate Change Streamflow Projections for South Central Western Complex Regional Basin



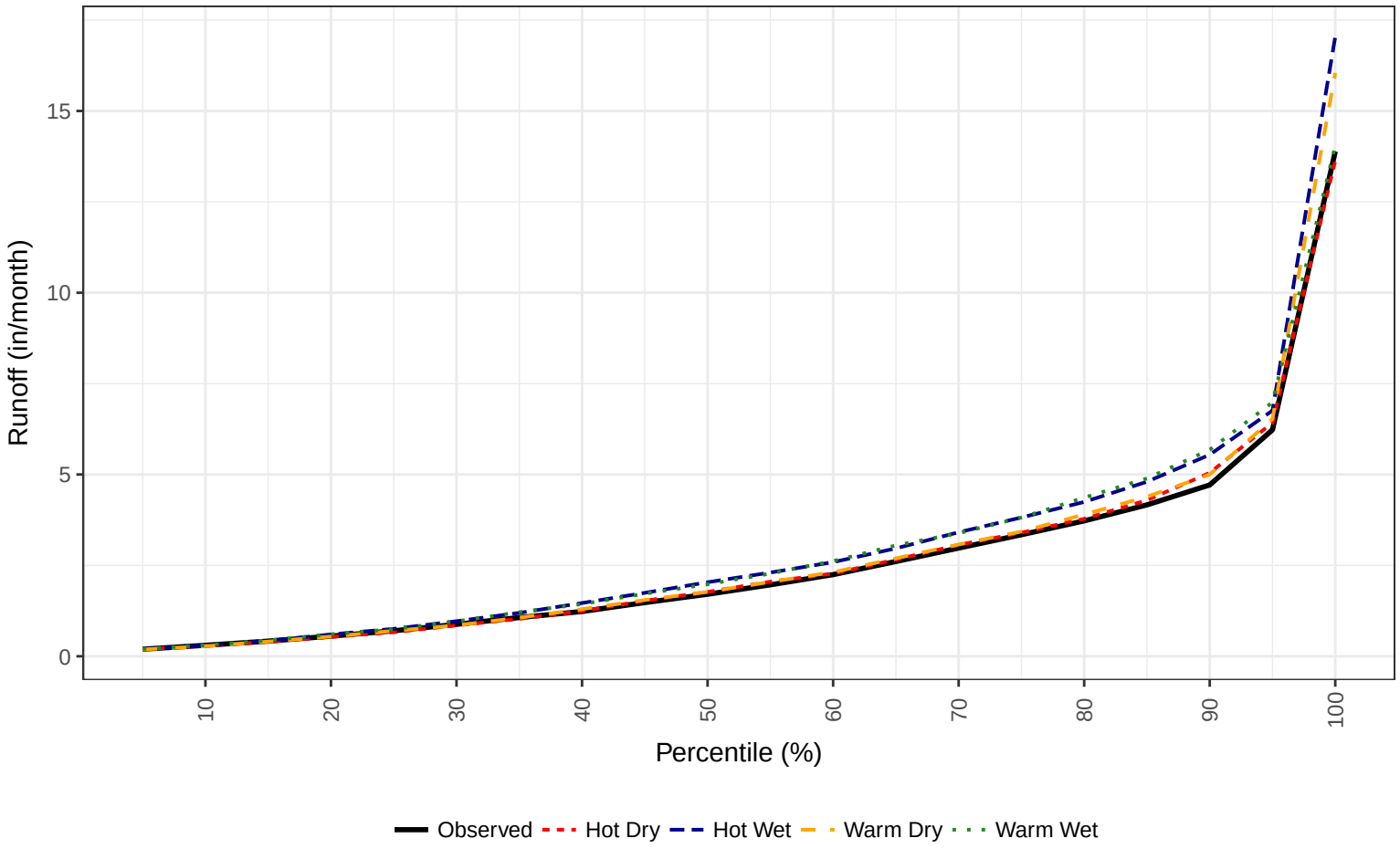


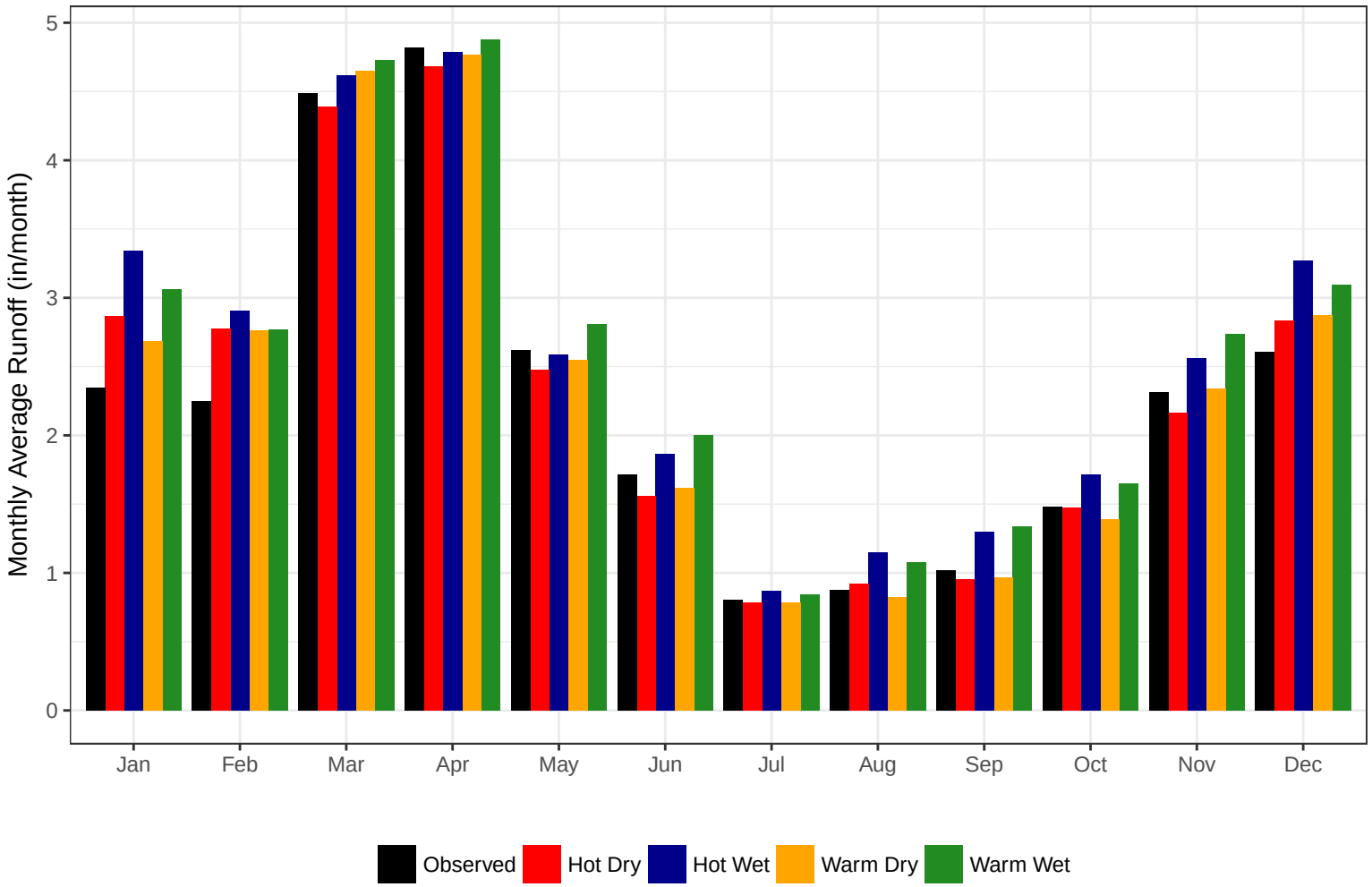
Climate Change Streamflow Projections for Housatonic Main Stem Regional Basin



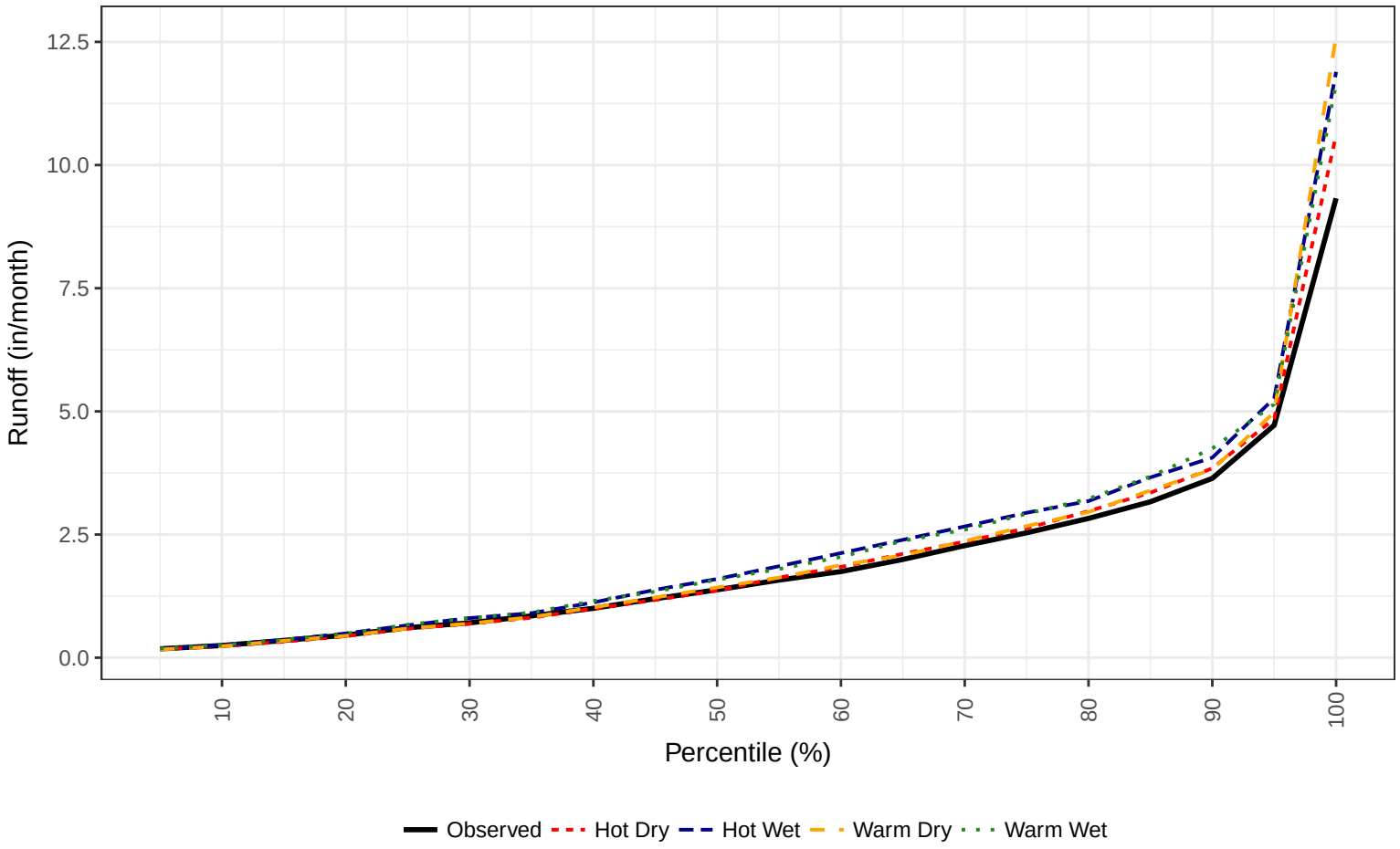


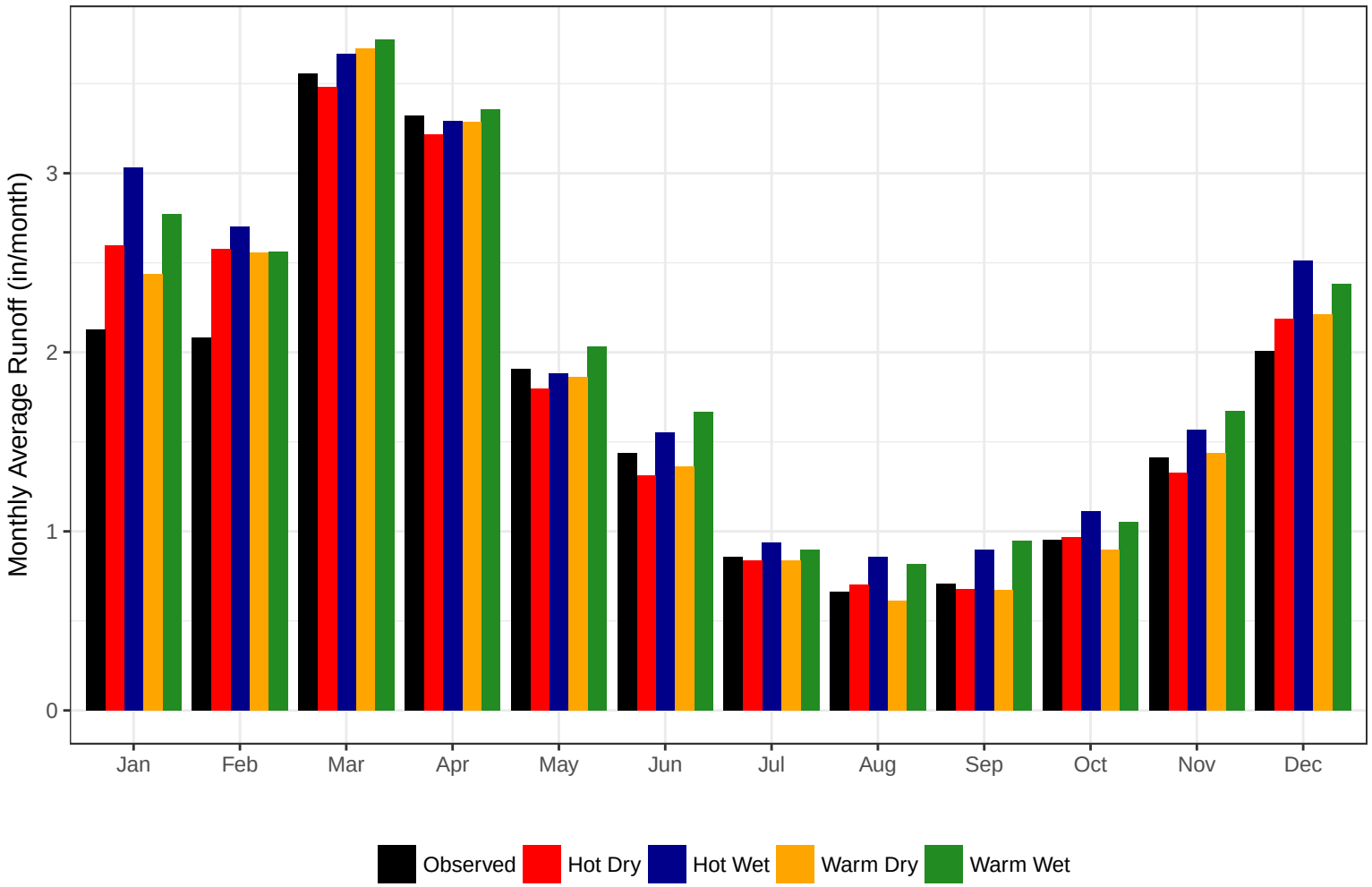
Climate Change Streamflow Projections for Blackberry Regional Basin



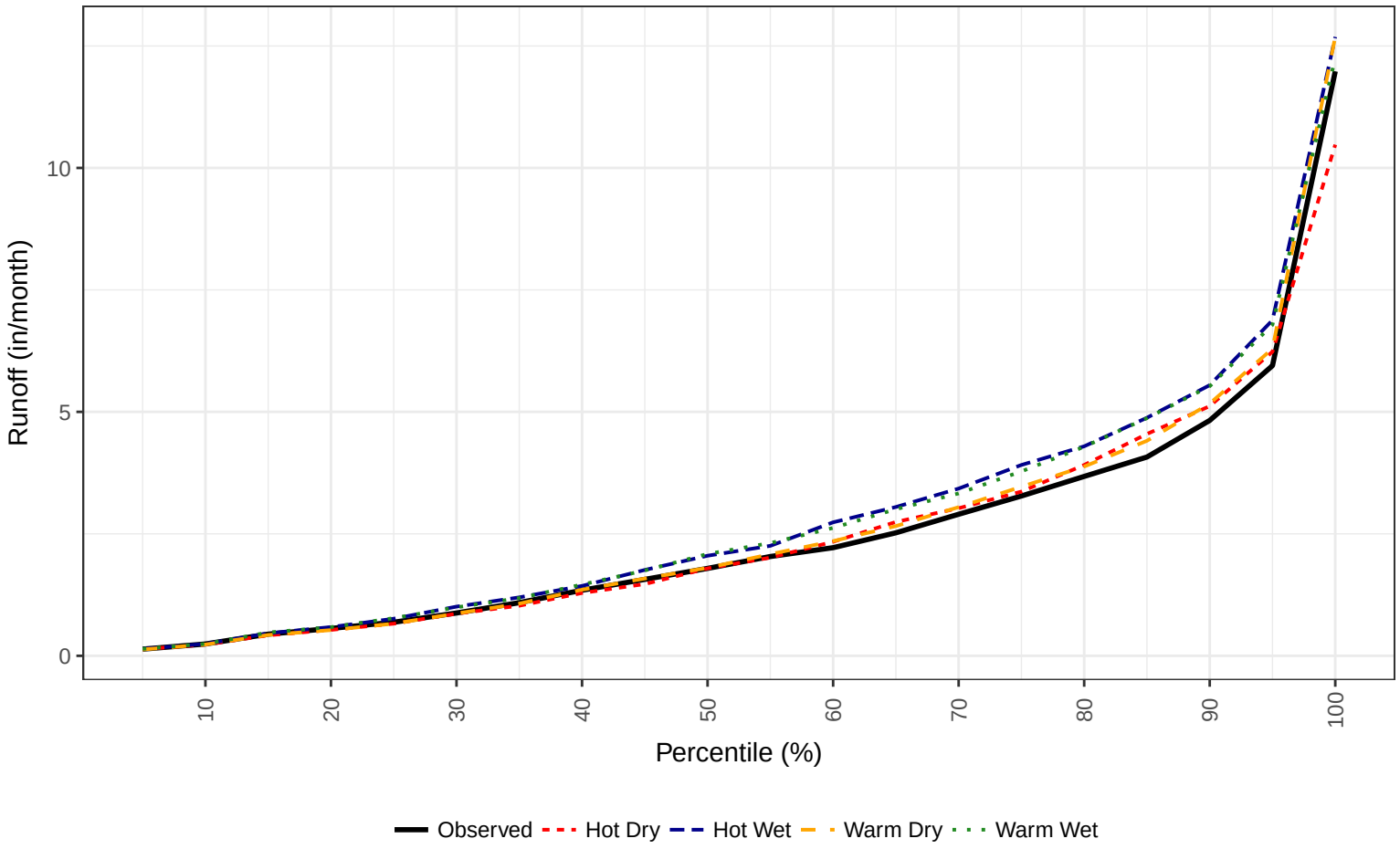


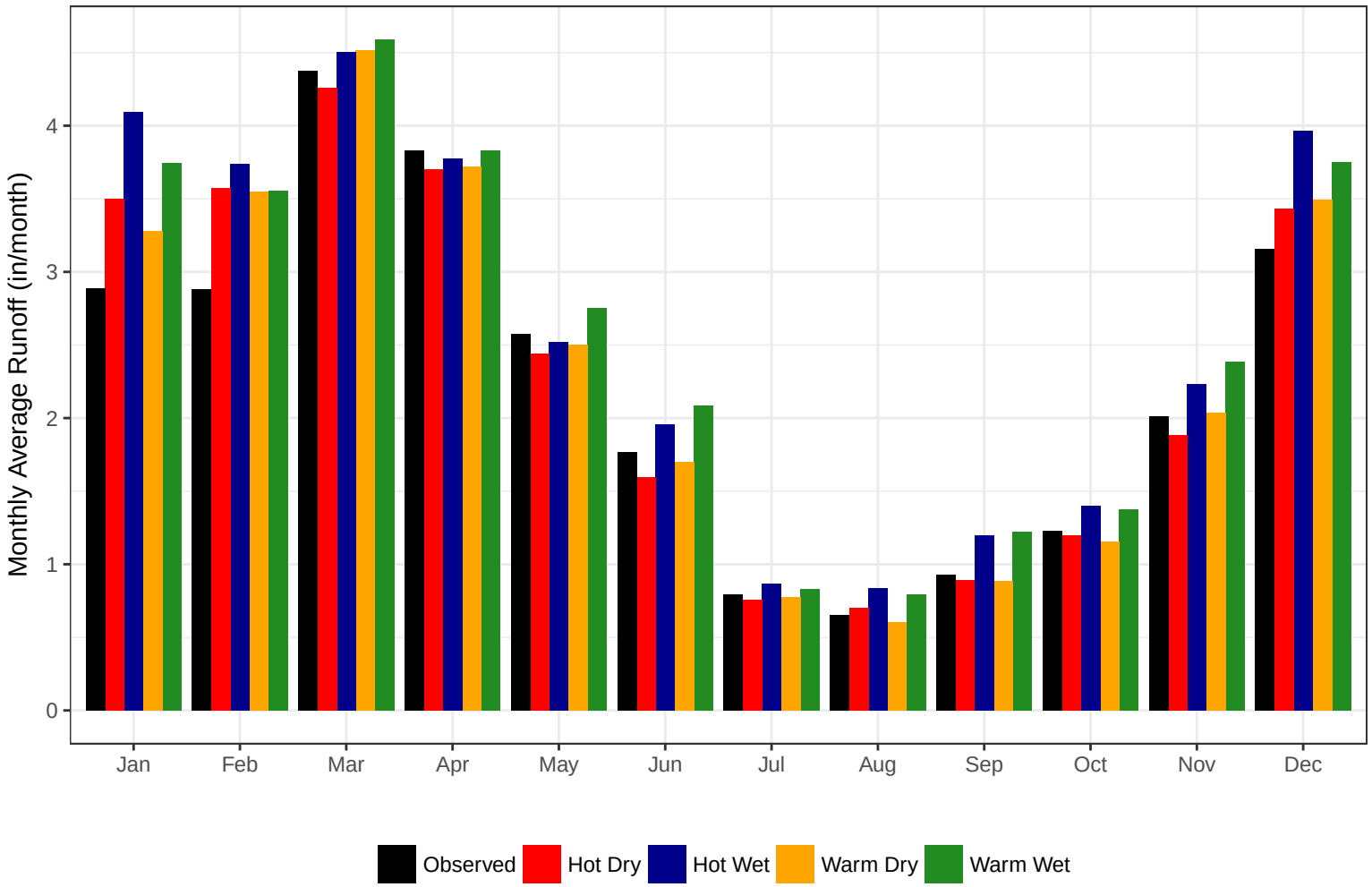
Climate Change Streamflow Projections for Hollenbeck Regional Basin



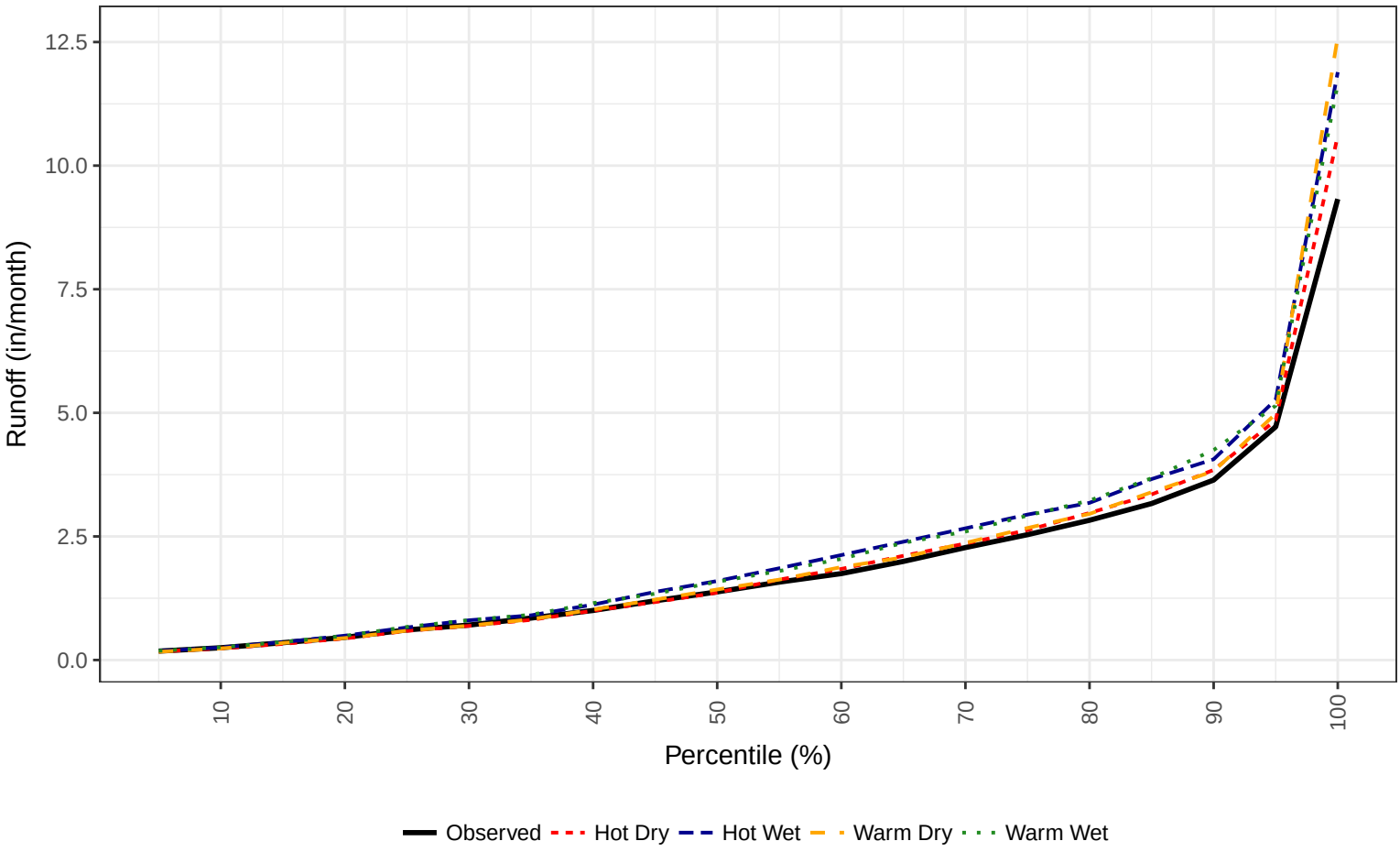


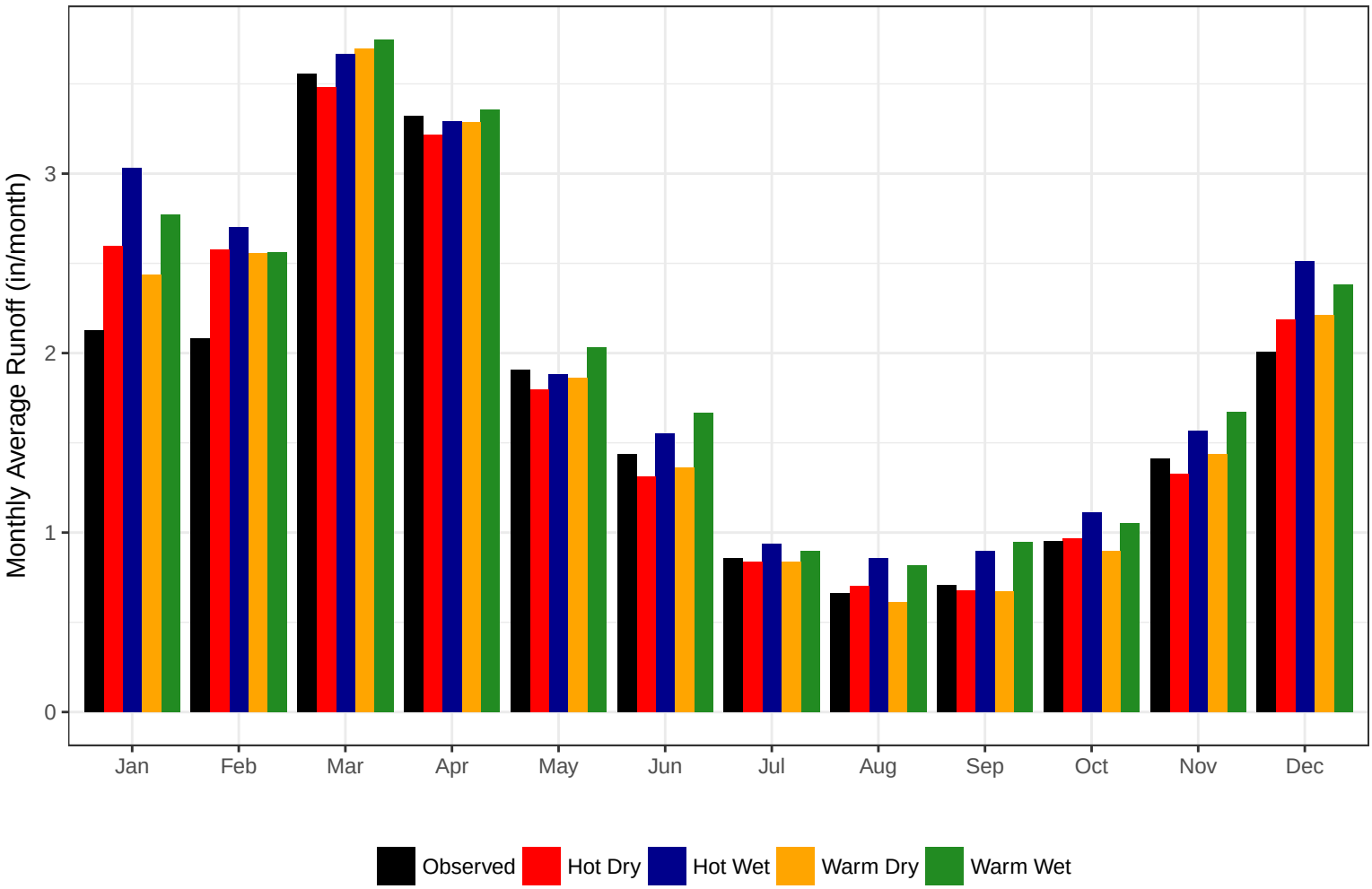
Climate Change Streamflow Projections for Tenmile Regional Basin



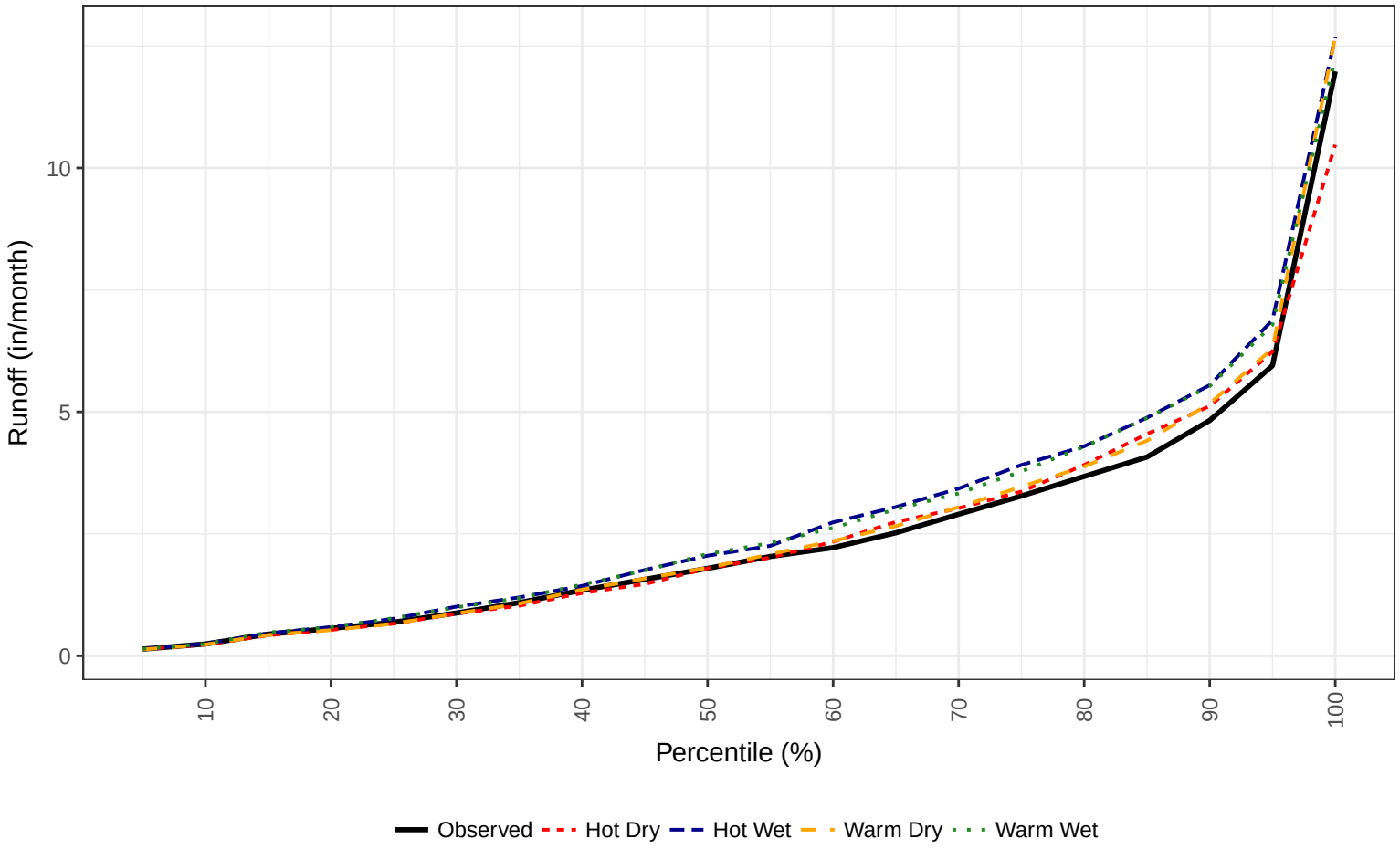


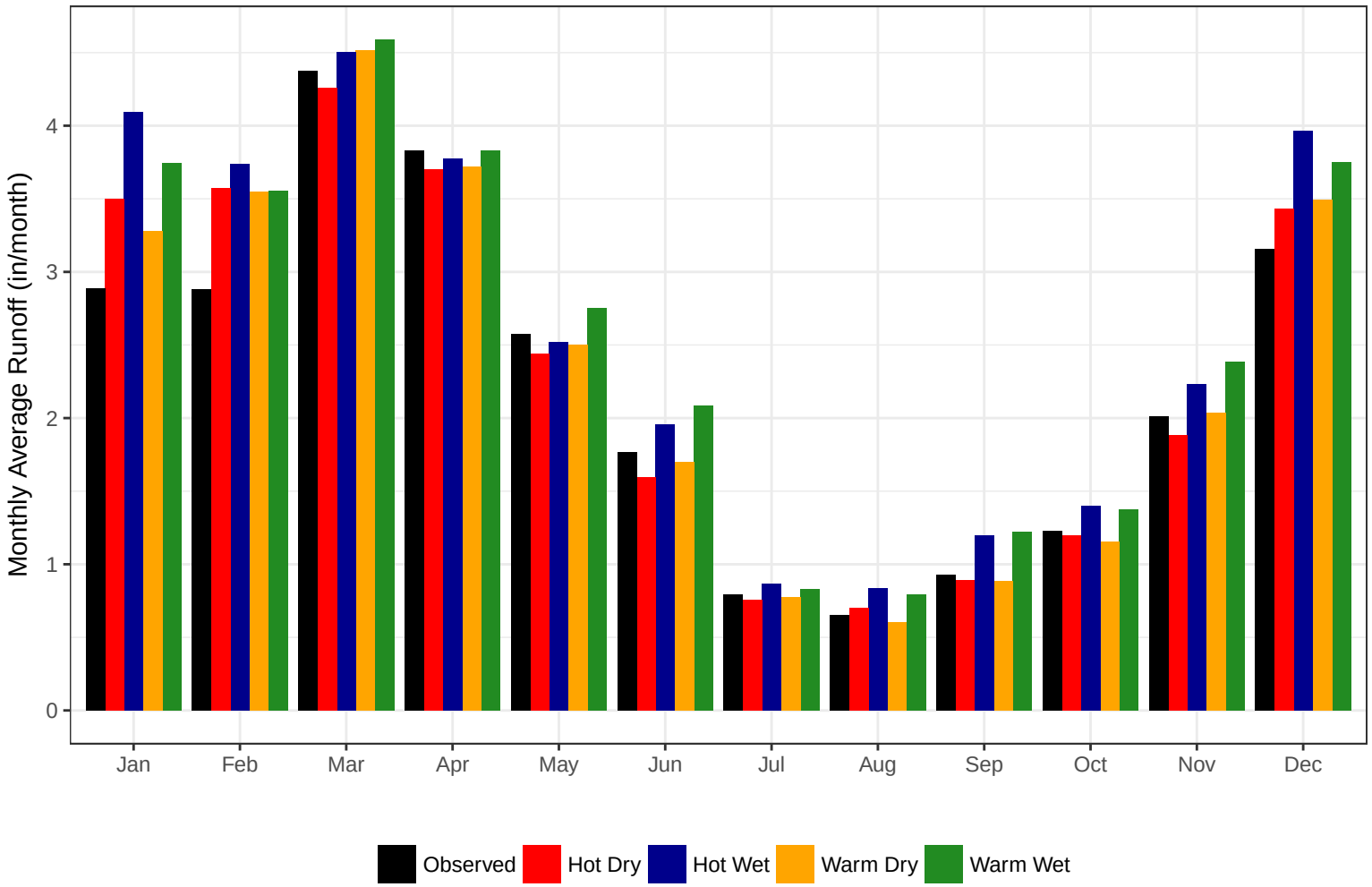
Climate Change Streamflow Projections for Candlewood Regional Basin



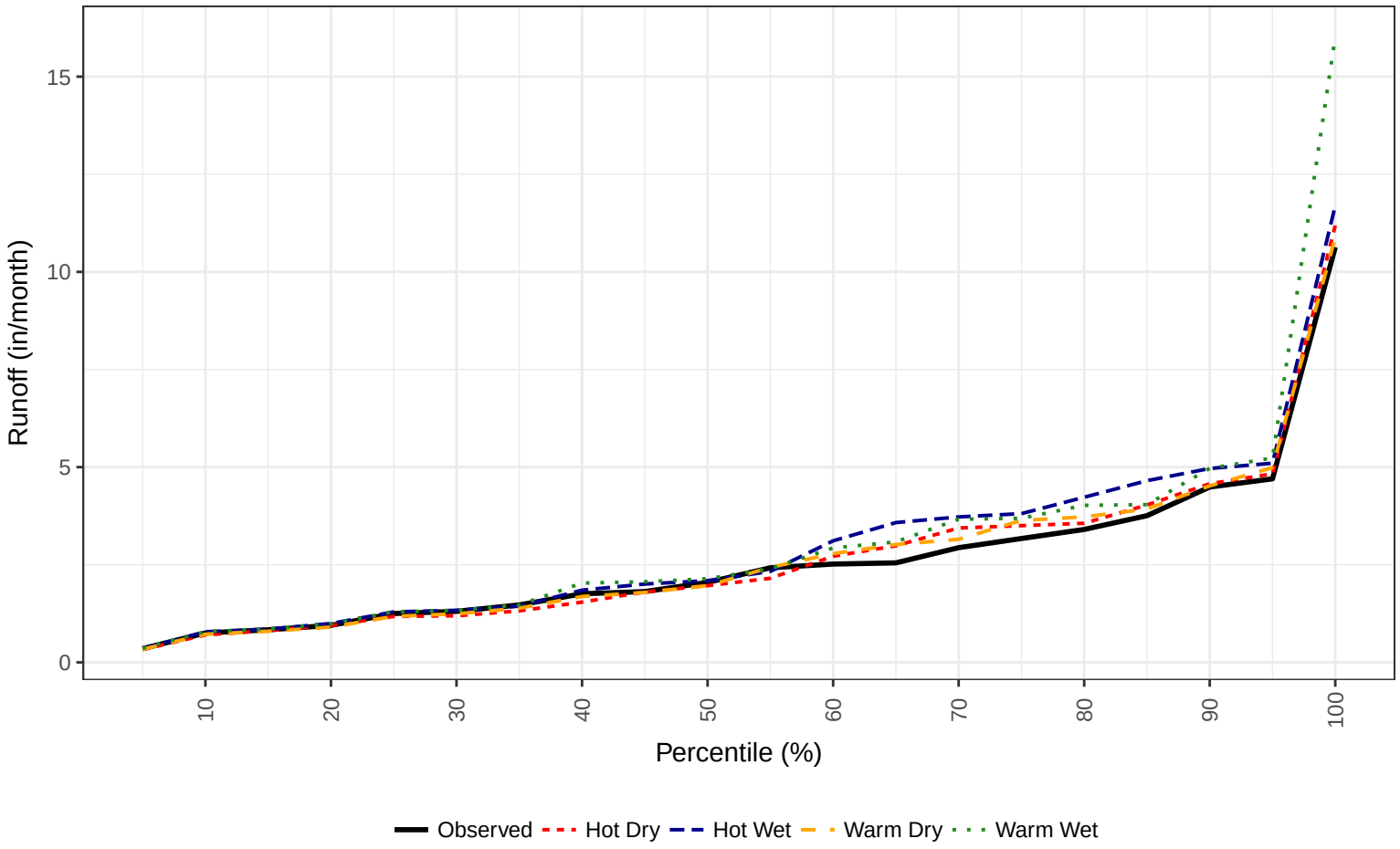


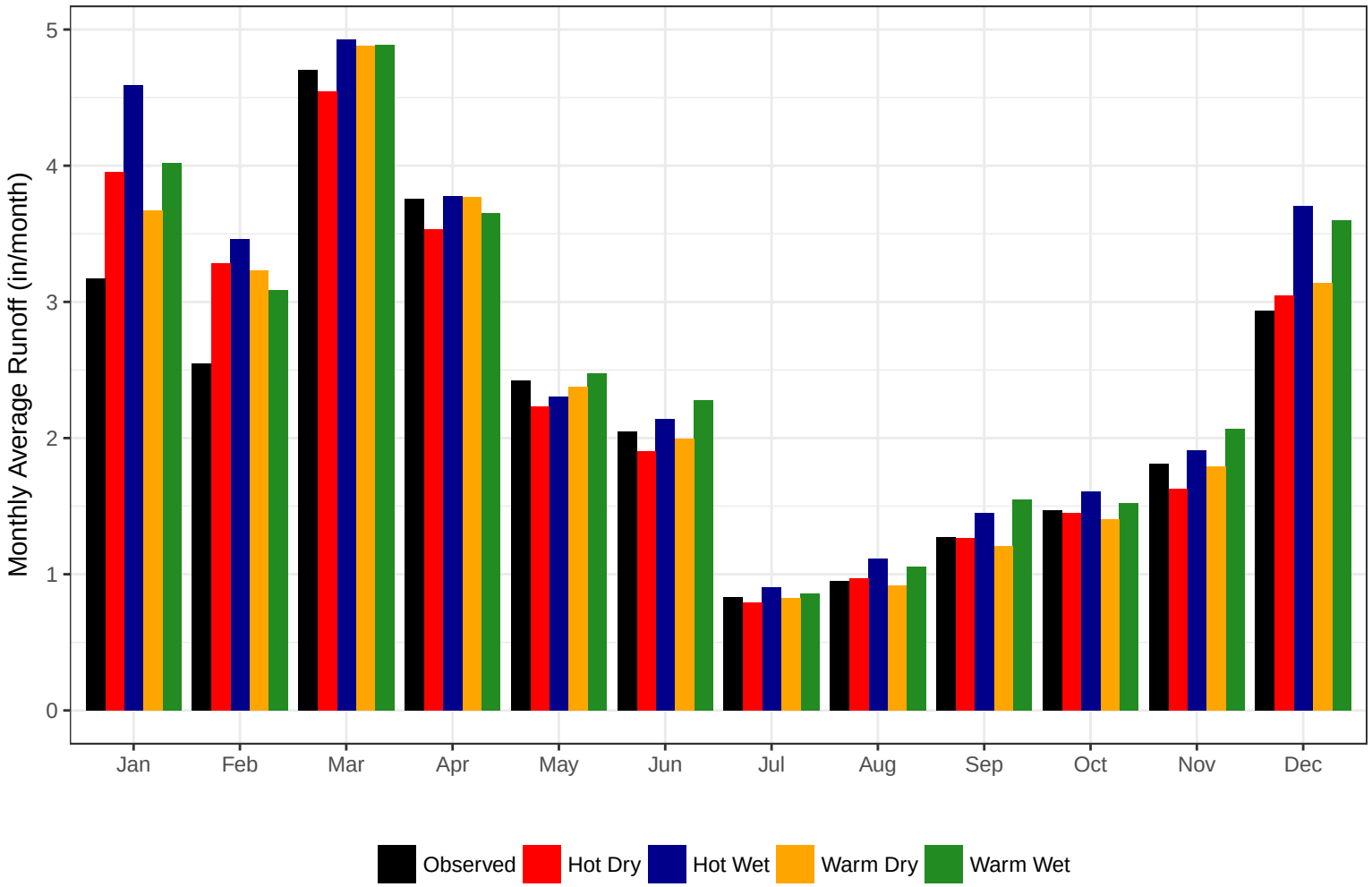
Climate Change Streamflow Projections for Aspetuck Regional Basin



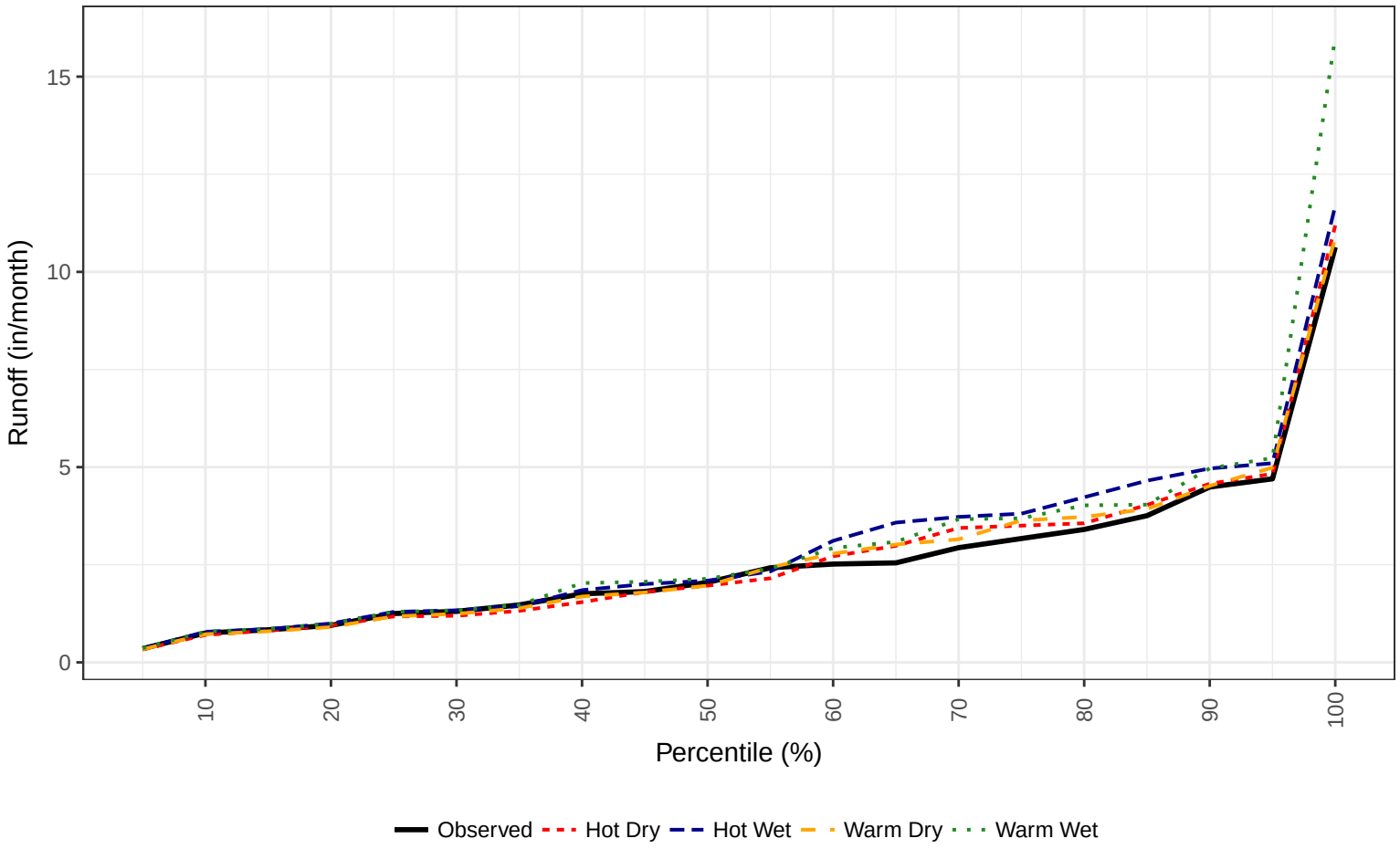


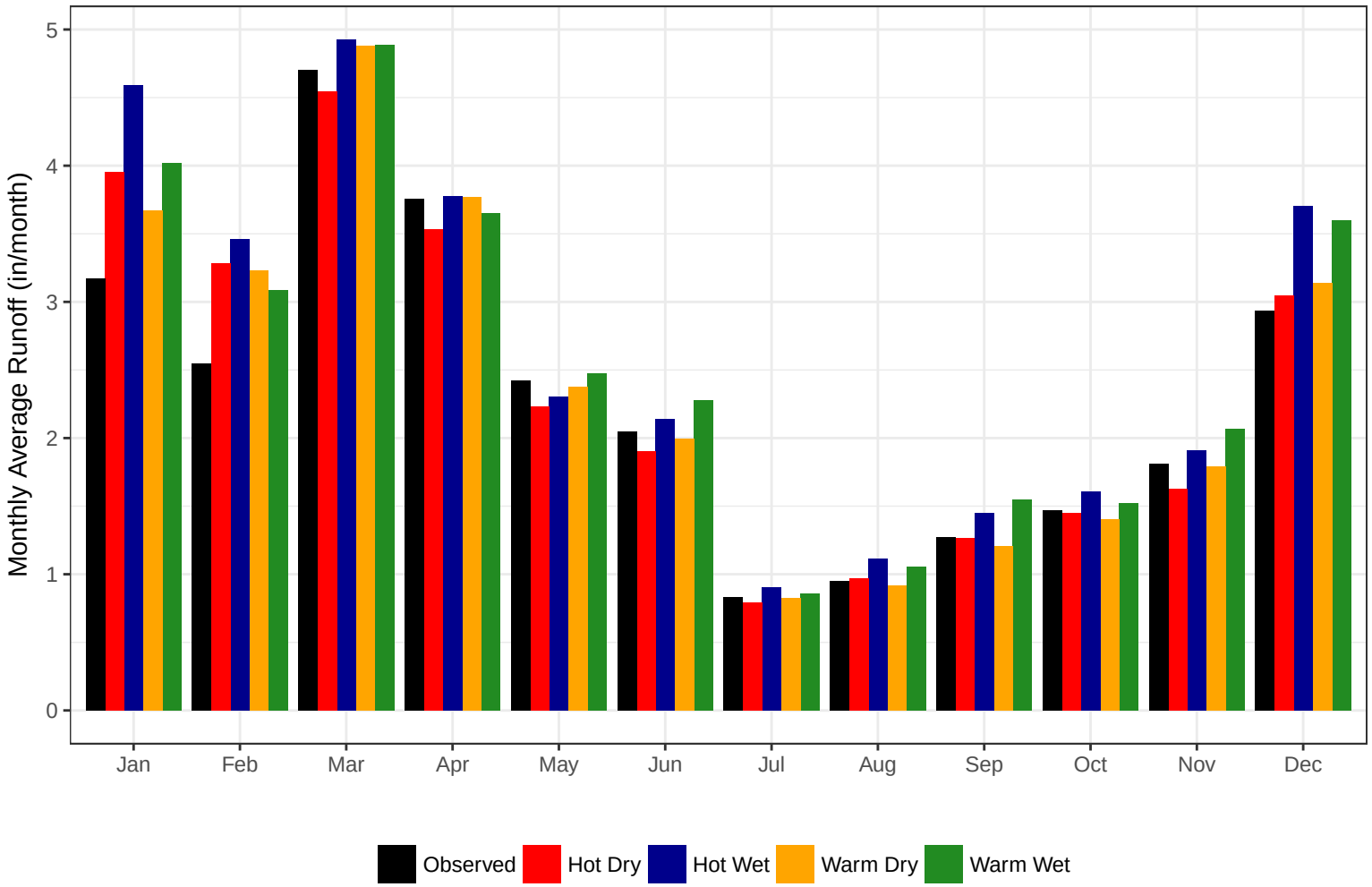
Climate Change Streamflow Projections for Still Regional Basin



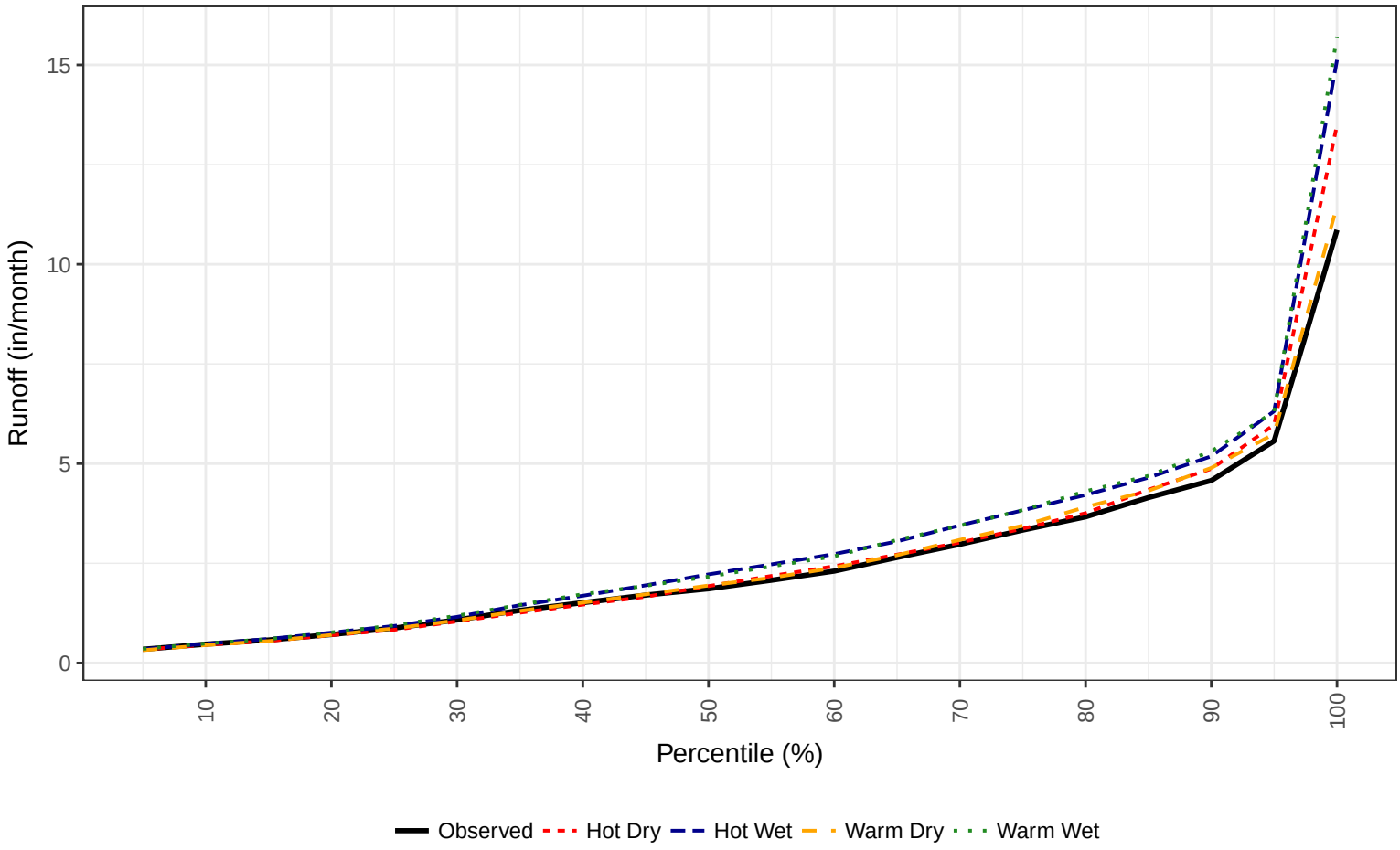


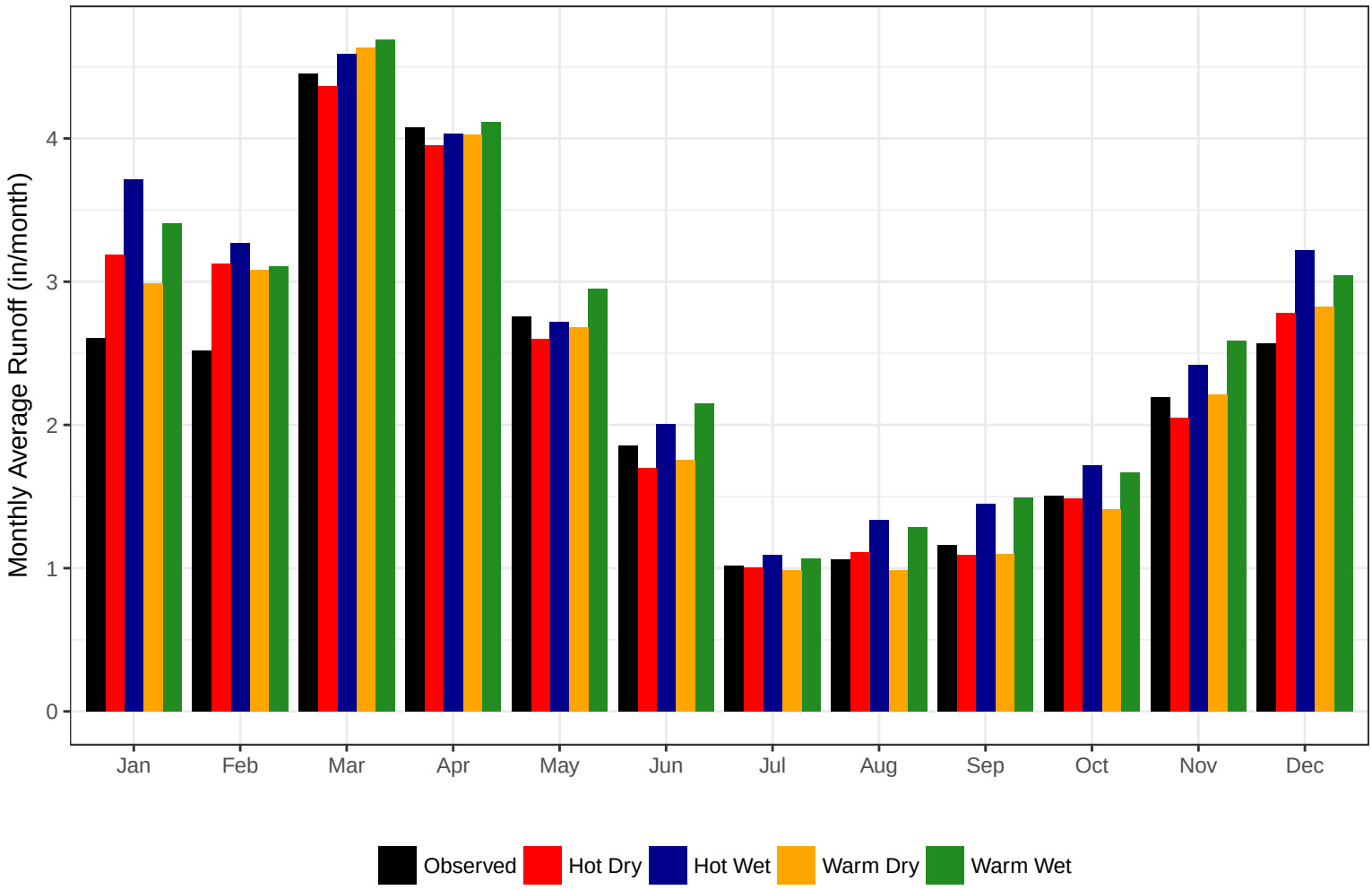
Climate Change Streamflow Projections for Shepaug Regional Basin



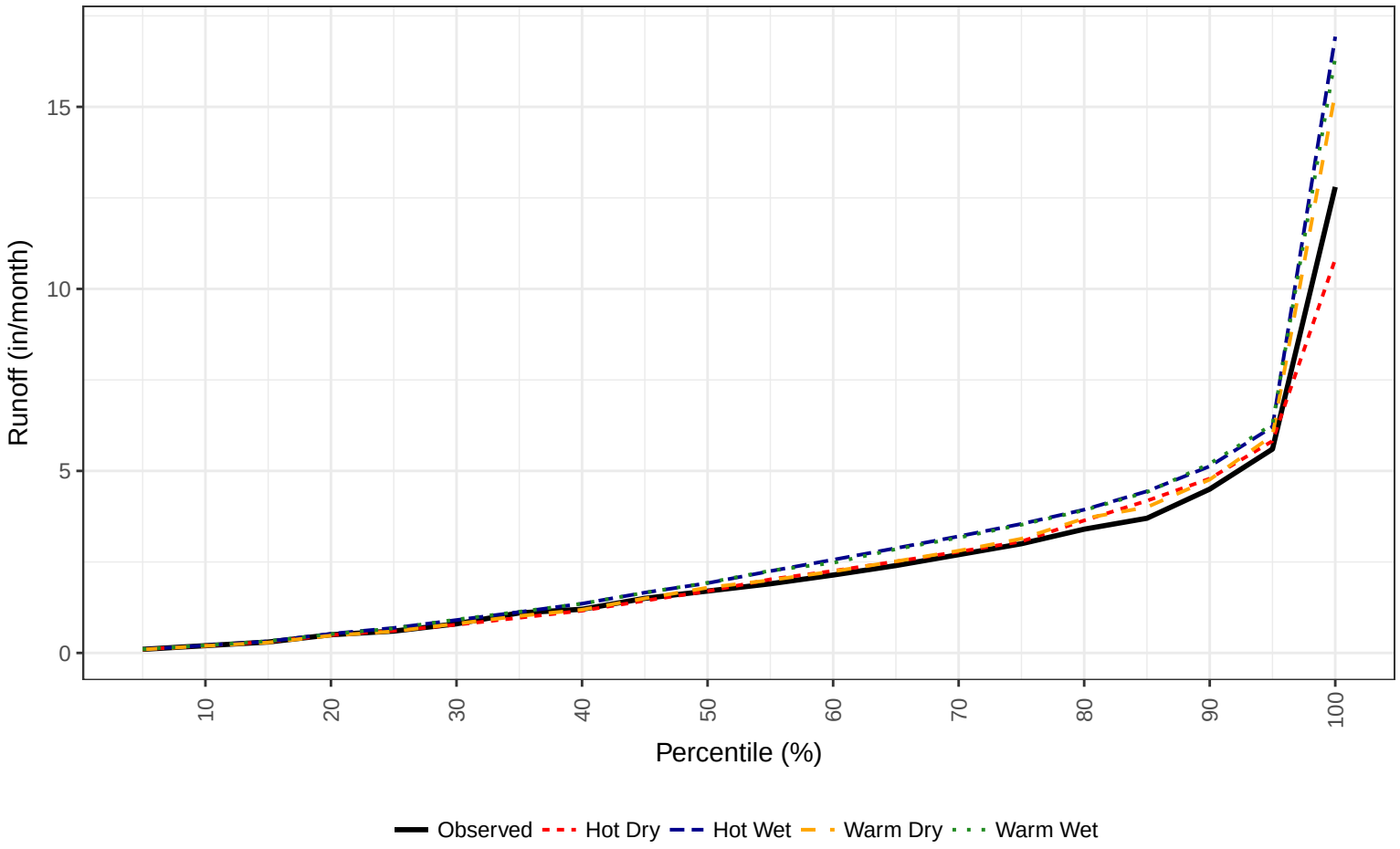


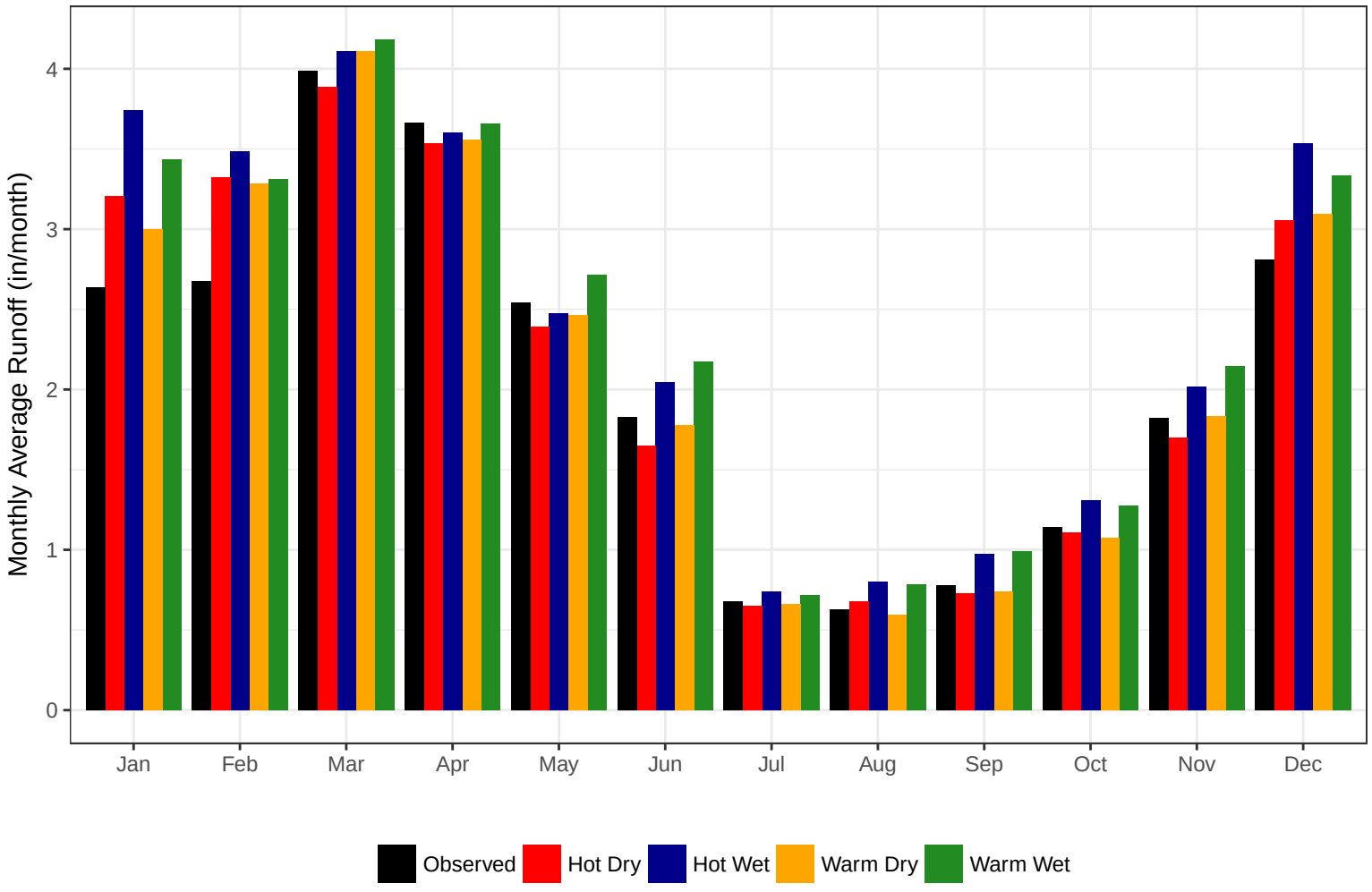
Climate Change Streamflow Projections for Pomperaug Regional Basin



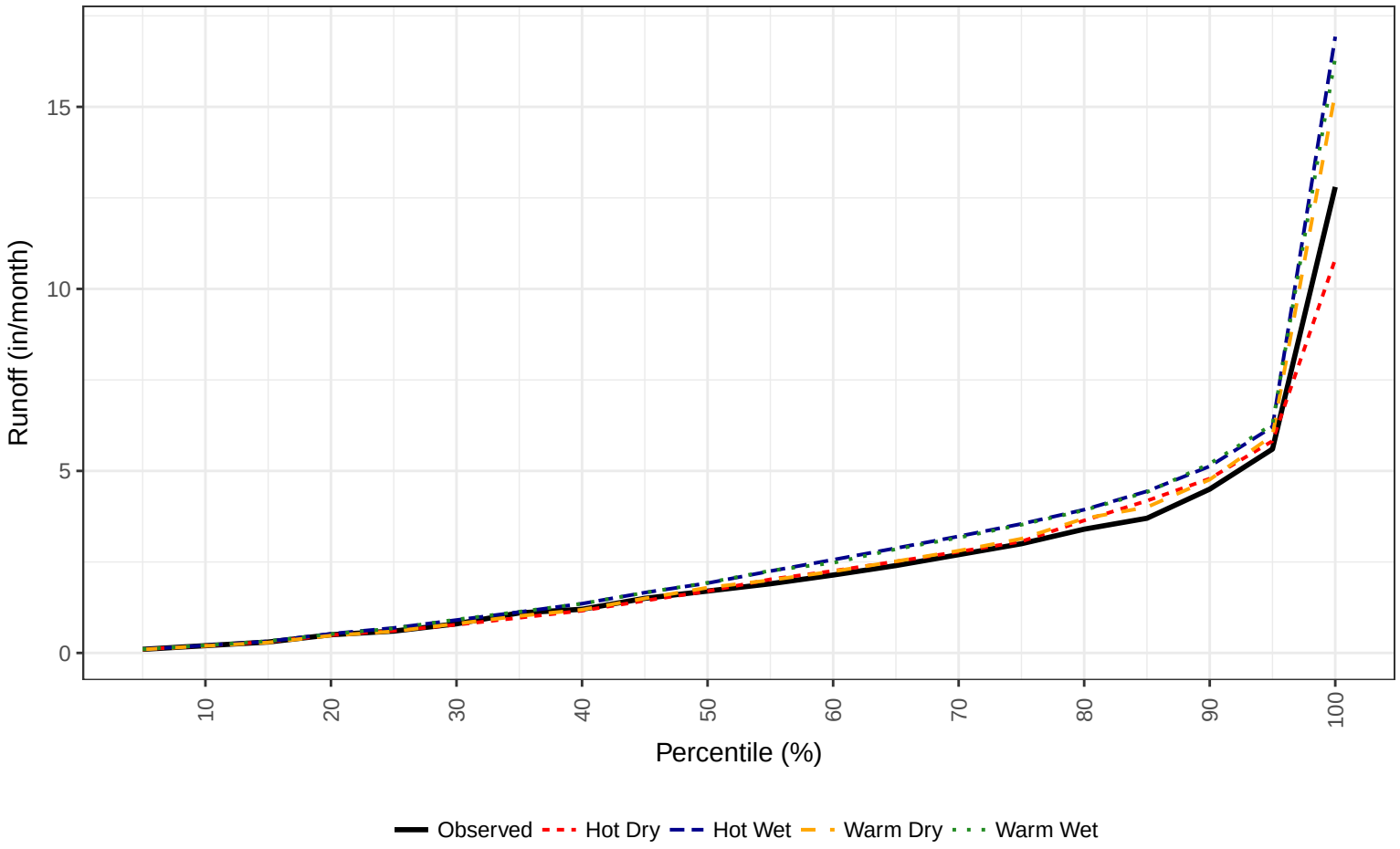


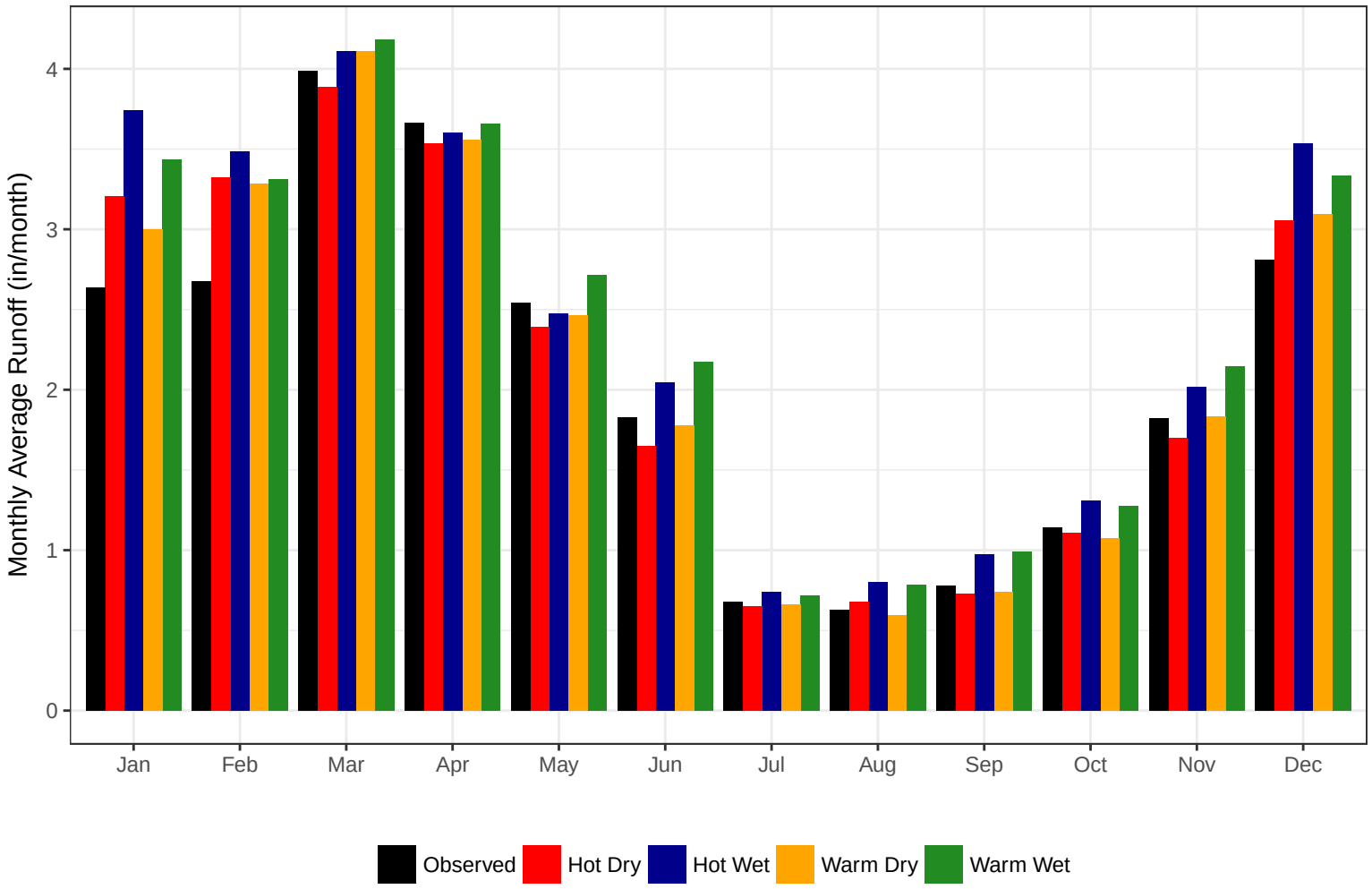
Climate Change Streamflow Projections for Naugatuck Regional Basin



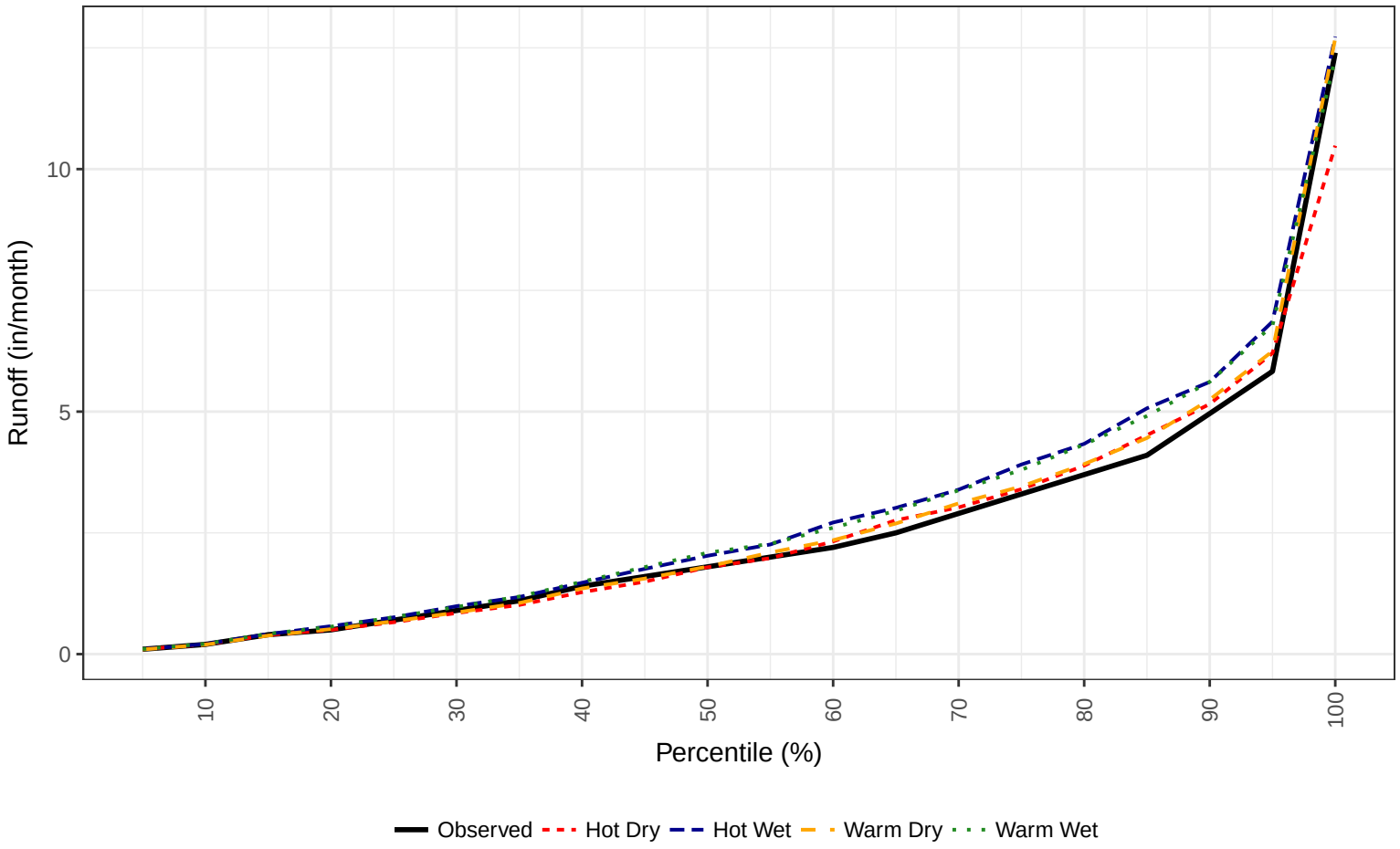


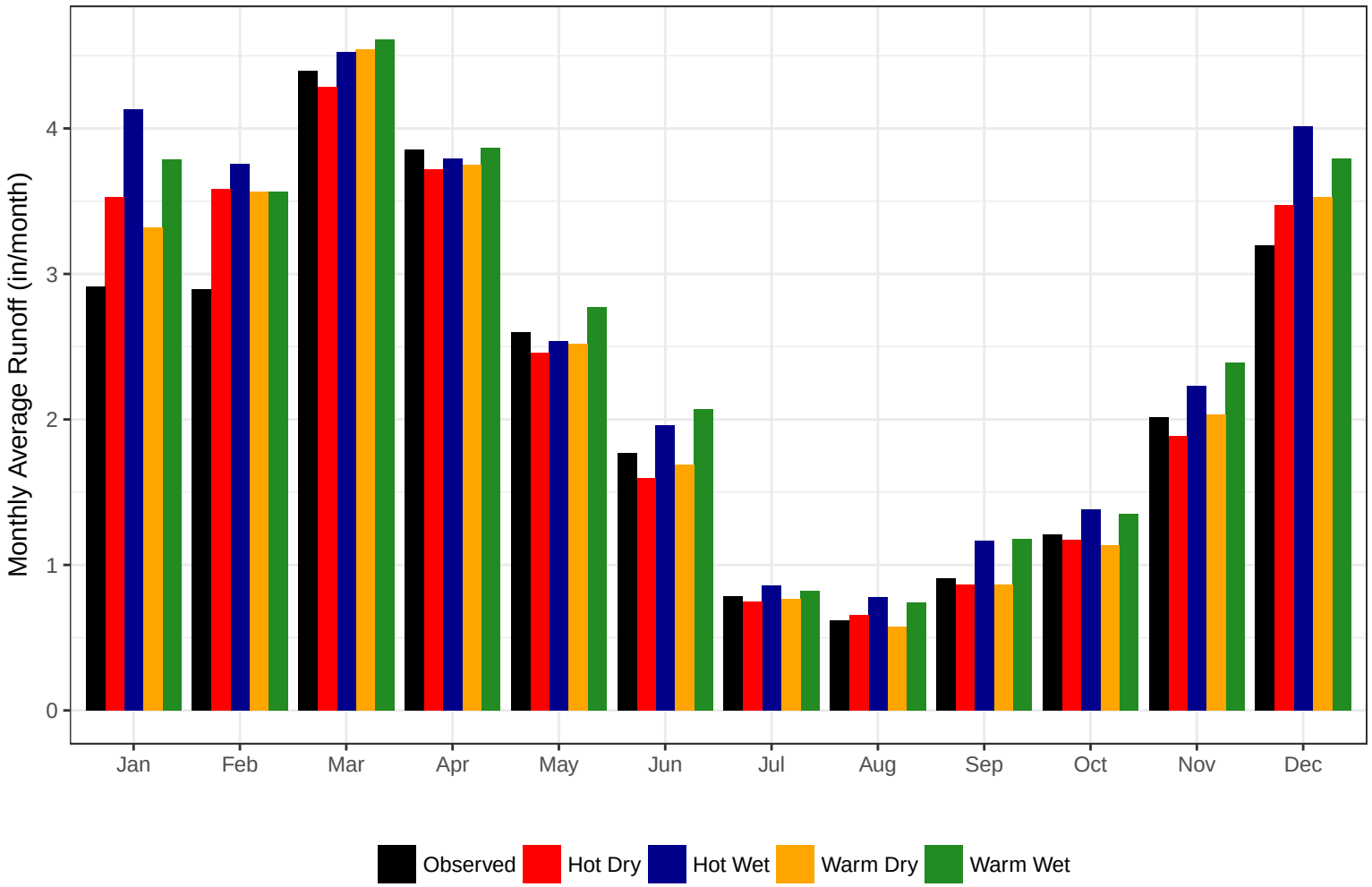
Climate Change Streamflow Projections for Southwest Shoreline Regional Basin



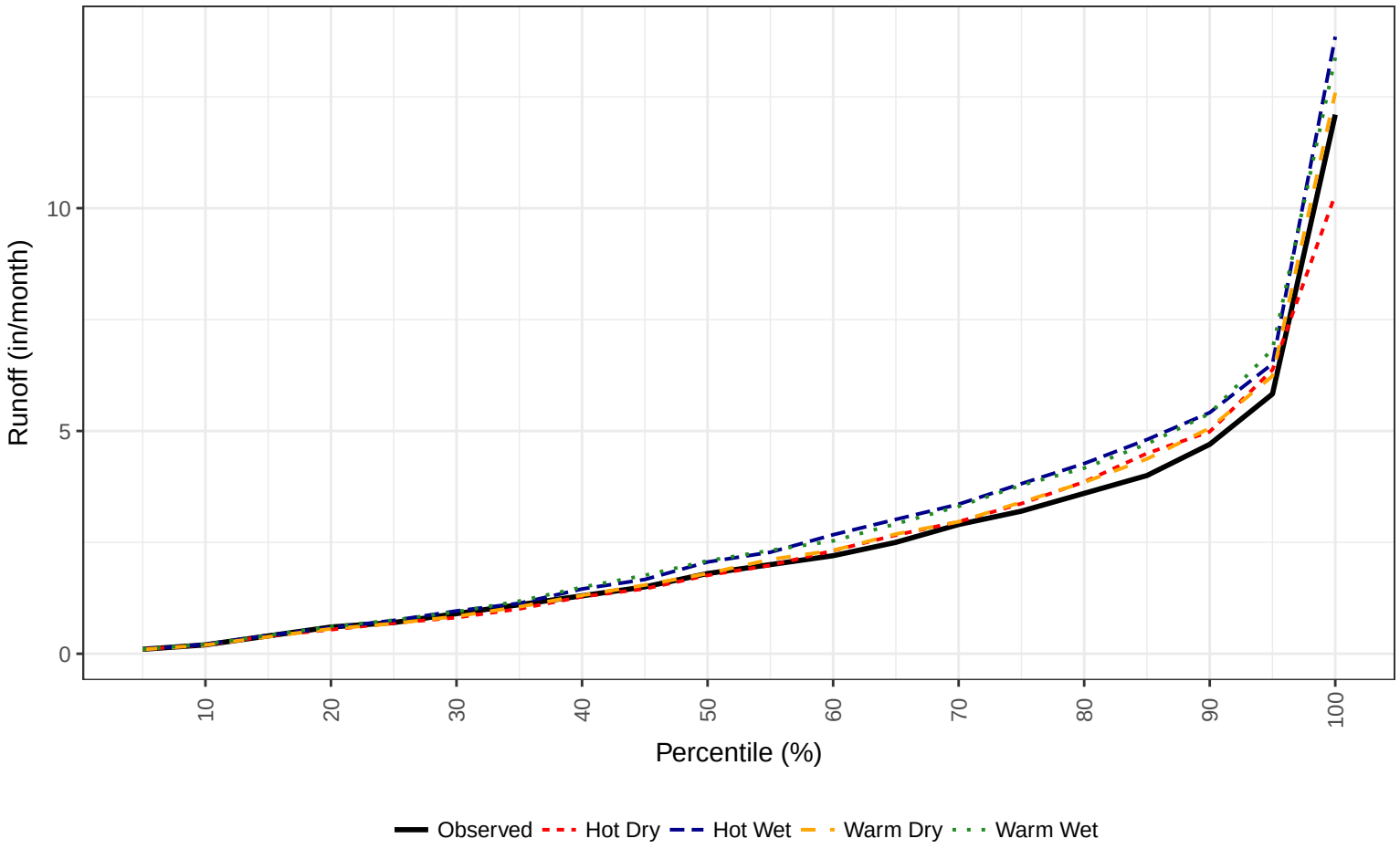


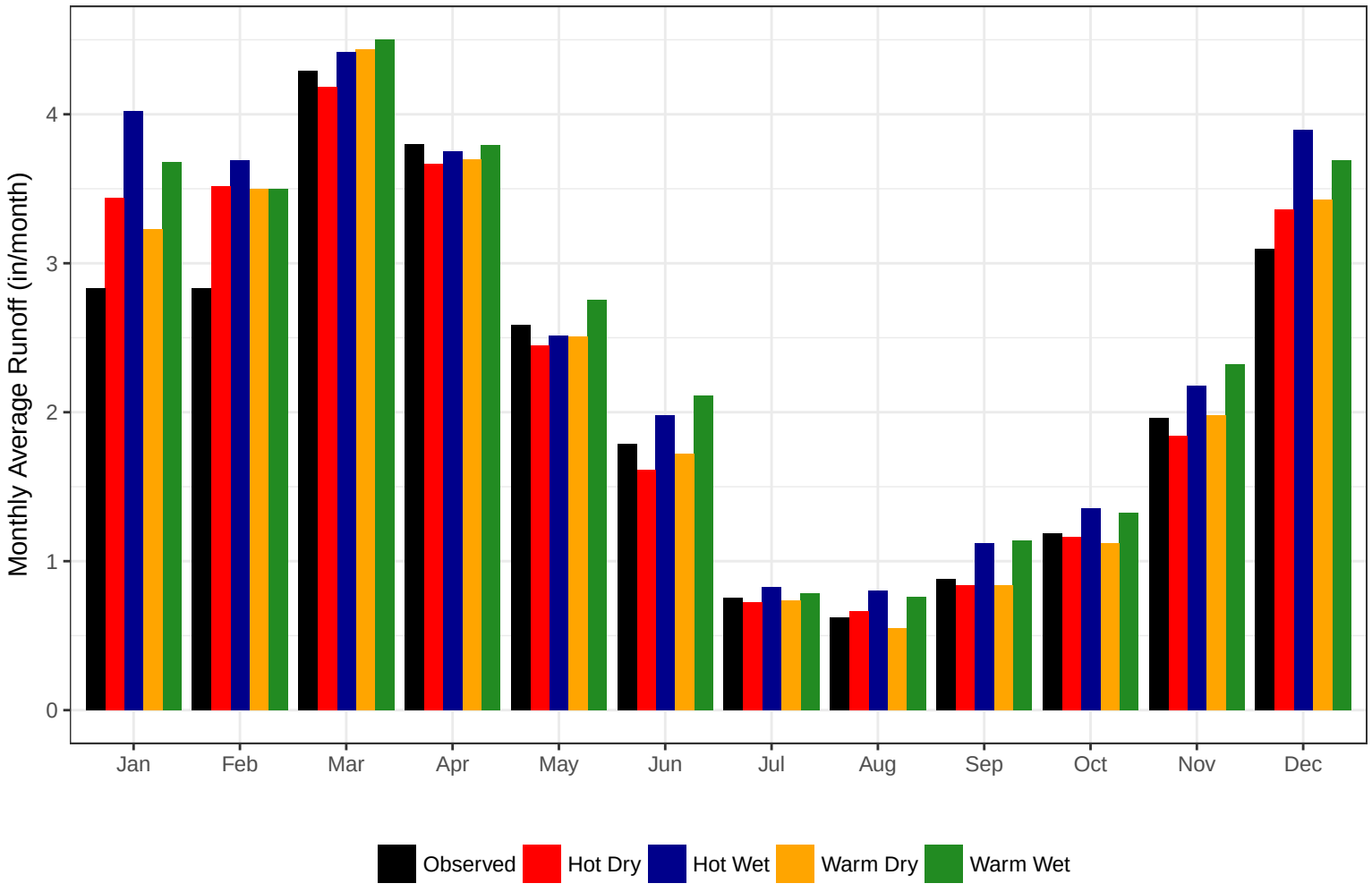
Climate Change Streamflow Projections for Southwest Eastern Regional Basin



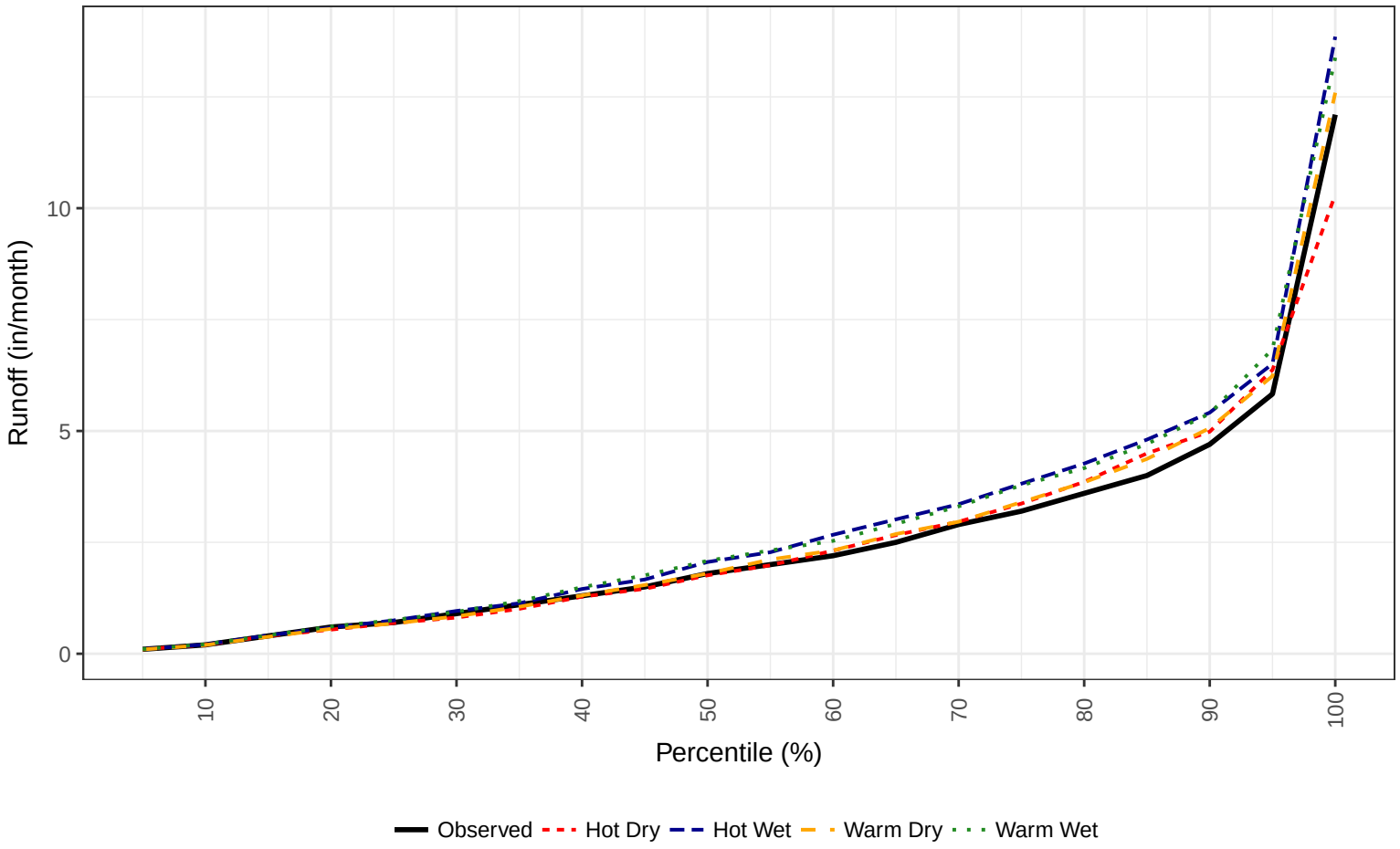


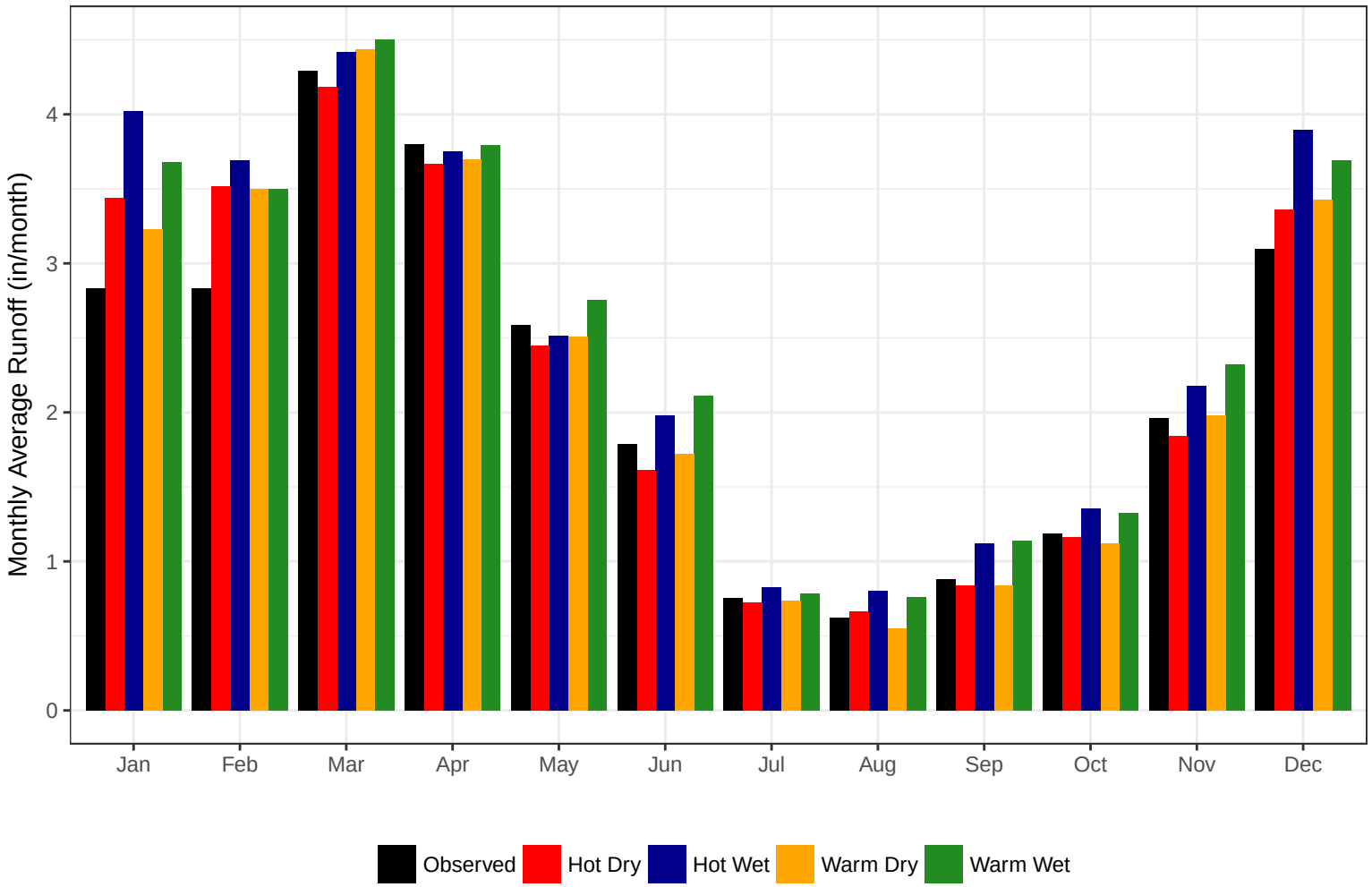
Climate Change Streamflow Projections for Saugatuck Regional Basin



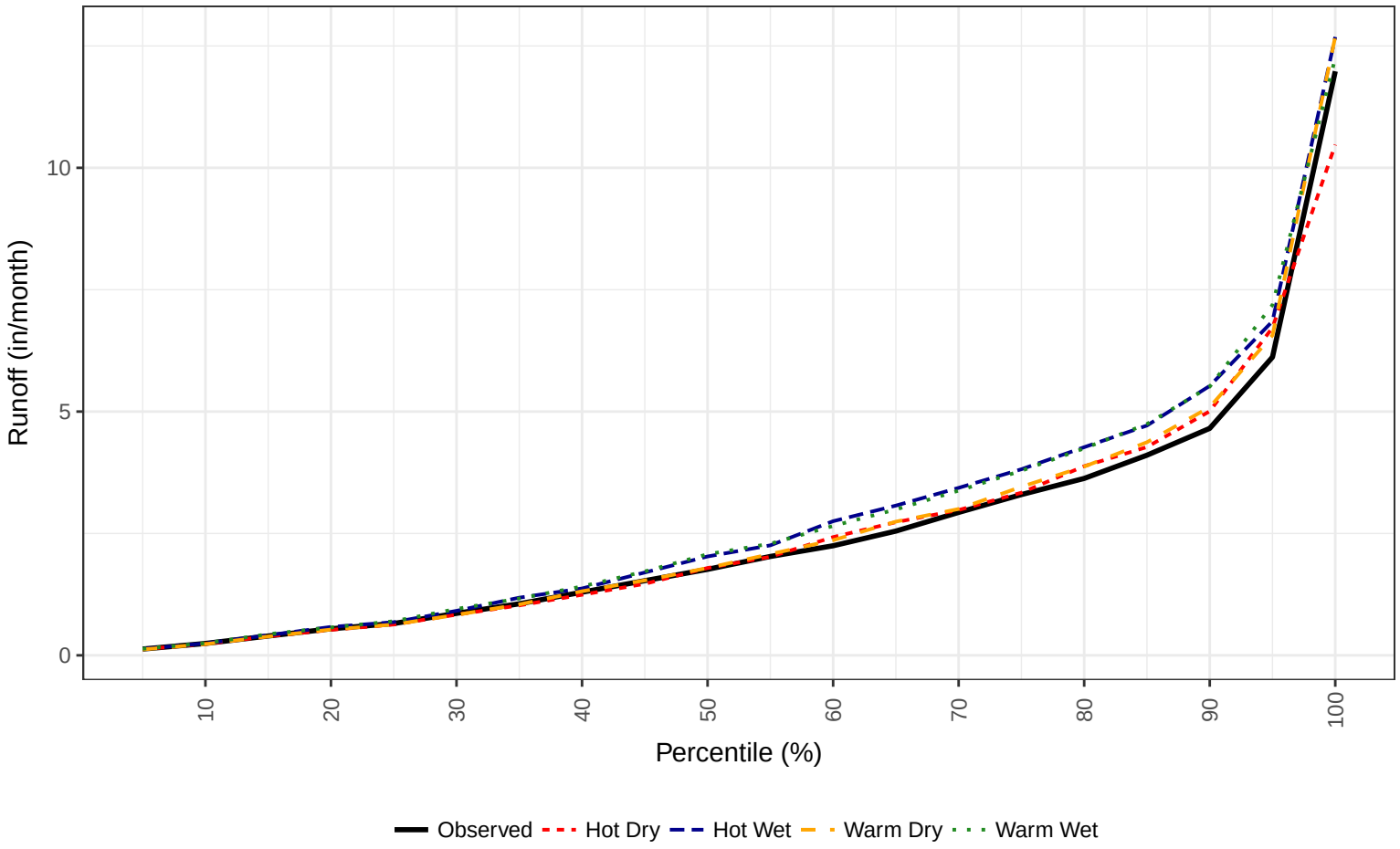


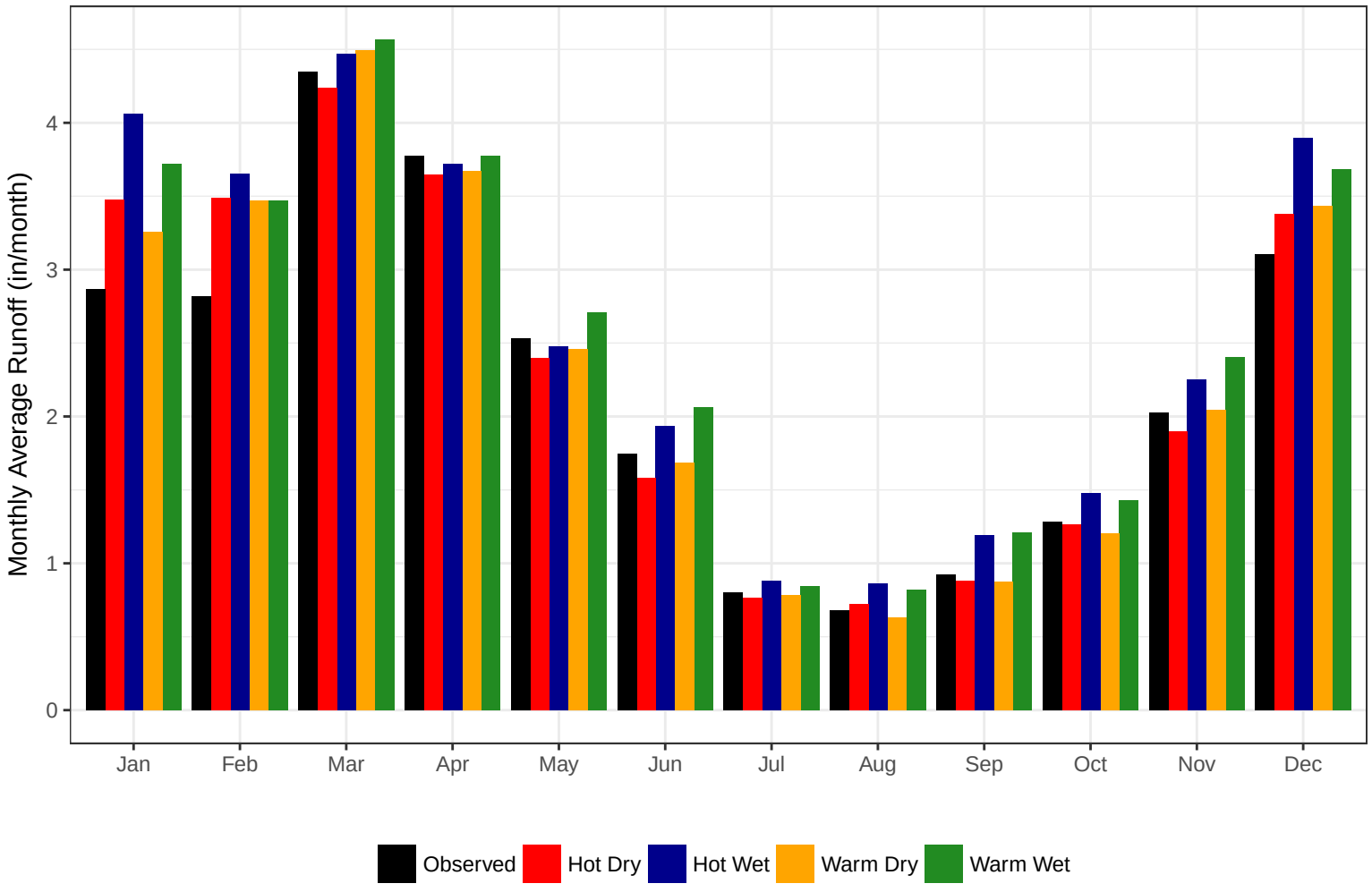
Climate Change Streamflow Projections for Norwalk Regional Basin





Climate Change Streamflow Projections for Southwest Western Complex Regional Basin





Climate Change Streamflow Projections for Croton Regional Basin



For more information, please visit ct.gov/water

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Prepared By: NEIWPCC CDM Smith Milone & MacBroom